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The Industrial Series

EDITED BY G. E. CONDRA

# THE WHEAT INDUSTRY

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TORONTO

THE WHEAT HARVEST

# THE WHEAT INDUSTRY

## FOR USE IN SCHOOLS

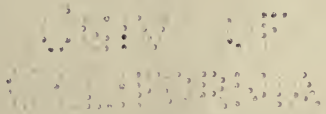
BY

N. A. BENGTSON, A.M.

AND

DONEE GRIFFITH, A.M.

DEPARTMENT OF GEOGRAPHY AND CONSERVATION
THE UNIVERSITY OF NEBRASKA



New York
THE MACMILLAN COMPANY
1915

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Set up and electrotyped. Published October, 1915.

Norwood Press
J. S. Cushing Co. — Berwick & Smith Co.
Norwood, Mass., U.S.A.

# INTRODUCTION

*The Industrial Series*, to which this text belongs, is designed for the purpose of making use of industrial studies in education. That the features of industry should be employed more as a means in education is now recognized. The organization of such data for use in schools is a problem, however, of considerable magnitude.

That the natural resources are of fundamental importance in shaping industrial development is generally understood. It is likewise known that the industries based on the resources have relations to the life and welfare of the people. Wheat is a resource of wide distribution and great importance in agriculture, manufacture, and commerce. This book seeks to make it of more use in education.

It is believed that industrial subjects of this kind are needed in the schools, because, first, they afford useful information, and second, they are in line with vocational training. Yet larger purposes lie in the fact that they stimulate interest, call for action and clear thinking, and thereby increase the efficiency of school work. Such industrial studies at this time are a part



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of the regular work of many schools. This text is designed for use in the upper grades of elementary schools.

The authors of this volume, Professor N. A. Bengtson and Miss Donee Griffith, have an intimate first-hand knowledge of the wheat industry, including all its processes of the farm, commercial movements, and manufacture. They have taught the subject in the elementary school, normal school, and university.

The editor is indebted to Professor R. D. Scott and Miss Myrtle Keegan for assistance in the preparation of the manuscript for the publisher.

G. E. CONDRA, *Editor.*

# PREFACE

"The Wheat Industry" is written in response to a demand for a connected treatment of the activities of wheat production. The almost universal use of wheat as a food places it in a position of exceptional interest. Its importance is realized, therefore people desire to know the story of the processes leading to its production. Wheat is a product entering largely into the channels of trade, and so is of great commercial interest. The great countries of the world can be studied with advantage from the standpoint of wheat. Thus we emphasize two major lines of thought in this volume — the processes of production, and the regional distribution of wheat.

The method used in the treatment of this industry is based upon the experience of successful teachers of industrial geography. It calls for active work on the part of the students under the guidance of the teacher, and uses the processes and products of wheat as objects of thought. This affords opportunity for excursions, written reports, class discussions, and independent work on the part of the students. The teacher should not lecture to the class. She should guide the stu-

dents in their efforts and lead them and stimulate them in doing individual work.

*Relation to School Subjects.* — In most schools this text will be used as a reference reader. In others, it will have a definite place in the seventh or eighth grade, closely correlated with geography. This is in line with the course of study which selects one or two important industries for investigation each semester or term. The relation to the regular school subjects is definite.

*Geography.* — First, the study requires the frequent use of geographies and atlases. In following the discussions on wheat regions and the markets and commercial movement of wheat, a demand will arise for the reading of the geography of the leading wheat countries. This gives the student a new point of view and leads him to see the countries in their industrial and economic relations. By tracing the commodities through their trade routes the student gains a clear understanding of commerce.

*Agriculture.* — Since the production is under different conditions as to soil and climate, these in turn influence both the processes and the production. Thus seeing the methods of wheat production in these countries, the student becomes better acquainted with the life of the people and their institutions. This is real geography closely related to agriculture.

*Language.* — The study will call for reports from students. These should be made in good form, whether

oral or written. The opportunity for language work is practically unlimited.

*History.* — The interest of many students is in history. Since wheat is a very old plant and its grain has been of use so long, there is in this the possibility of developing a definite trend in industrial history.

*Domestic Science.* — Domestic science now implies more than the routine work of the kitchen. The teacher or housewife is interested in wheat because it enters into more food relations than any other cereal. Understanding the processes of milling adds to her intelligence and efficiency. She desires to know why certain kinds of wheat make better flour for baking purposes than other kinds. She also wishes to know how methods of bread making and the shapes and sizes of loaves differ in various countries.

Thus it is seen that the story of wheat is closely related to a number of school subjects and that such correlation will add interest and value to all.

*Excursions.* — Some may be content with reading about wheat without asking questions or making excursions to see the things described. By seeing wheat in the field, by watching the binder and thresher, by studying milling and other processes we, however, gain first-hand knowledge. In some schools trips are made for this purpose. It is difficult for some students to make excursions and it is even more difficult for teachers to find time to conduct them. Although it may often be difficult for students, and even more difficult for

teachers, to find time for these field trips, they should, if possible, be made. The gain in power to observe closely and describe carefully more than repays for the time spent. It is hoped, however, that time can be found for field trips, that the students may be courteous to those who assist them, and that they will carefully write up the observations. The ideal of every one should be to observe closely and to describe accurately. Of course all observations should be carefully written up, and it should be understood that excursions made with the teacher are for a definite purpose. They are school work in the field.

Perhaps the best results from field observations will come from student trips which are made alone or in small groups. Many observations of this kind may be made while traveling at vacation time. Not all have the privilege of travel, yet those who do may see industrial things well worth the time and expense. A trip to a big wheat farm of the West, or to a large flour mill at Buffalo or Minneapolis, will be a pleasure when made for a purpose.

*Collecting Specimens.*— The wheat plant in different stages of growth may be collected from the field by students or secured by writing to persons who live in wheat-growing regions. Some school supply houses sell these, as well as wheat products, for school use. A very good place to see illustrative materials is in commercial museums of cities. Some of the large milling companies send specimens of wheat and its

products to schools upon request. These show the grain, the flour, and each process in flour manufacture. It is better, however, for the class to collect such specimens while studying a mill and its operations.

Products such as breakfast foods, crackers, etc., can be obtained from stores for the asking. Specimens secured for class study should be used freely. Those to be retained permanently by the school should be labeled and placed in cases.

*Questions and Exercises.* — At the end of each chapter is a set of questions and exercises. The questions serve to guide students in study and in class discussion. They may be answered orally or in writing. Persons reading the book for information and not making a careful study are not expected to answer the questions.

The exercises are to be worked out or omitted as the teacher and class may decide.

The authors have received much valuable assistance in the preparation of this text. The Editor of the series, Dr. G. E. Condra, has generously assisted in outlining the discussion and has freely contributed valuable suggestions. Miss Jeannette C. Nelson, Department of Geography, University of Nebraska, has assisted in gathering the data used in the text. Miss Minnie Gant of the Lincoln, Nebraska, city schools and Miss Mary Johnson of the Los Angeles, California, city schools, have given helpful criticism from the standpoint of grade work.

The illustrations are largely from photographs taken

by the authors. Many others, however, have kindly assisted in furnishing views suitable for use. Special acknowledgments are due the following: Frank H. Shoemaker; R. A. Lindsay; Physiographic Laboratory, Cornell University; H. J. Young; E. L. Currier; Holt Manufacturing Company; New York State Board of Agriculture; Pennsylvania Railway; Norfolk and Western Railway; International Harvester Company; Washburn-Crosby Mills; Loose-Wiles Biscuit Company; New Seattle Chamber of Commerce; Canadian Pacific Railway; Winnipeg Grain Exchange; Pan-American Union (views on Argentina); Department of Agriculture, New South Wales, Australia (views on Australia).

The authors are indebted to Mr. E. D. Kiddoo for the preparation of the index.

N. A. BENGTSON.
DONEE GRIFFITH.

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# The Wheat Industry

## CHAPTER I

### *TO THE READER*

This book is for students of the schools, but it may be of interest to others. It is an industrial story of wheat. Most people know that wheat is an important plant in several countries, and we have learned in geography that it is widely cultivated. The grain is what is meant, however, and not the plant, when we use the term wheat in a general sense.

The word *story*, as here used, does not have its usual meaning. Industry has to do with resources, labor, manufacture, and products. These are all included in the wheat industry. The whole story of wheat, involving everything done with it on the farm, during shipment to markets, in the mills, and in the factories, is included in this description. Our book starts with the processes in wheat raising and follows the grain and its products through the mills and markets. This is the reason for calling it the industrial story of wheat.

People generally know something about the wheat industry. Students in or near the country see such processes as plowing, seeding, harvesting, and threshing, and may be able to describe them. These persons, however, may not have a knowledge of how the grain is handled at the big markets

FIG. 1. — The wheat field in its country setting.

nor how it is manufactured into flour at the mills. Those of us who live in the city may have seen large shipments of wheat at the elevators and mills. Some of us may have visited mills where wheat is made into flour, or bakeries where flour is made into bread, yet we may know very little of how wheat is grown. The agricultural processes are no better understood by the city child than are

the mills and markets by the country boy. So it is that city folk and country folk alike do not fully understand the whole story of the industry.

We do not all realize that wheat is extensively raised in countries where methods of production are very different from ours. To some of us,

FIG. 2. — City view showing elevators and railroads.

plowing carries a picture of a great steel machine drawn by a traction engine; to others the view of a riding plow pulled by three horses is called to mind. But many do not know that in parts of Asia large fields are still prepared by crude wooden plows pulled by oxen or camels. Threshing in the Pacific Northwest is done by huge machines which

both harvest and thresh the grain, whereas in some other countries the cradle and flail are still in use. The seasons of planting and harvesting are likewise different. Our harvest occurs during the time of year when Argentina has its winter. The people of Australia are cutting their wheat when we are sitting around the fires and telling stories of Santa Claus. These are illustrations which merely indicate the world-wide importance of wheat.

To learn of the different methods of production practiced in other lands will lead us to a better appreciation of the life and problems of other peoples. Surely such a subject is of interest and value.

Our story takes up the discussion in the natural order, — from the seed to the finished products and their uses. The first part of the book deals in detail with the processes employed in wheat production. The latter part applies this discussion to the chief wheat raising countries of the world. Thus knowing the order in which the processes come in the industry, we can make our own outline of topics.

### Questions

1. What is an industry?
2. Suggest several reasons why an industrial study of wheat should be of interest to all.

## CHAPTER II

### *THE WHEAT PLANT*

Botanists tell us that wheat is a grass. Its development from a wild grass to that of the domesticated plant of to-day is fairly well known and forms an interesting study. From the standpoint of industry, however, we are more concerned with its present than its past. The wheat plant is one of our leading life resources, for it yields the world's greatest bread cereal. Let us become better acquainted with this plant before taking up the industry of which it forms the basis.

**The Parts of the Wheat Plant.** — The plant is all that grows from one seed, and its parts are the roots, stems, leaves, and heads. These work together in producing the grain. The young plant appears to be for the most part leaves and roots. The older plants have prominent stems or stalks supporting heads, called spikes. In these heads are formed the flowers and kernels. A brief description of these parts will serve to show what the wheat plant is like. Learning some of these things will prepare us to understand the processes

in cultivation, harvesting, and manufacture, which will be discussed in later chapters.

FIG. 3. — Wheat plants. Note roots, stalks, leaves, and spikes. Several stems may, because of tillering, grow from one seed.

*The Roots.* — The roots are the underground part of the plant. As the wheat kernel germinates it sends out a root from its lower end; this is soon followed by two others; and these first three are called *temporary roots*, because they serve the plant for but a short time. After the stem has pushed above ground the permanent roots develop. These grow in whorls from joints on the stem a little below the surface of the soil. They grow outward to varying distances from the stem, and then turn

sharply downward. These roots are branching fibers which not only serve to hold the plant in position, but also to gather from the soil moisture and food materials which are later converted into plant and grain. Few of us realize how extensive is the root system of the wheat plant. Sometimes the roots penetrate to depths of 4 to 7 feet, and the roots of a single plant may, if laid end to end, measure more than 1500 feet.

*The Stems.* — The stems are, by some, called *culms*. They are short and not very noticeable in the young plant. As the plant becomes older and the root system well developed, the stems rapidly lengthen and become hollow, jointed tubes. The length of the stem differs with varieties, soils, climate, and seasons. Common wheat usually grows from three to four feet high. The color is green while the stem is growing but changes to yellowish at harvest time.

As a rule each wheat seed produces several stems. This is a desirable quality, for it makes possible a large yield of grain for the amount of seed sown. The method of growth which produces so many stems is called *tillering* or *stooling*. Rich soil, abundant moisture, early seeding, and thin stands favor tillering. Sometimes fifty or more stems spring from a single seed. In most fields, however, the number is from four to eight.

The stem is quite strong and rigid, and holds the

leaves and head in the air and sunshine. It also serves as a passageway to transfer food materials from the roots to other parts of the plant. The upper part of the stem remains green until late in the period of ripening and seems to do work similar to that of the leaves in manufacturing food for the grain.

*The Leaves.* — The leaves are long, slender blades growing from the stem. They are close together on young plants and become farther apart as the joints of the stem lengthen during growth. The leaves are small workshops as well as breathing machines, and do a very important work for the plant. They are filled with small canals through which solutions flow, and the surface has innumerable pores which admit air. Moisture and food material are transferred from the roots to the leaves, and gases are taken directly from the air. Within the leaves, with the aid of sunlight, these food materials, gases, and moisture are combined and changed into food substances such as starch, sugar, and cellulose. The leaf products are carried to the heads of the plant and built into fruit or grain. With abundance of moisture and a rich soil these processes make rapid progress with the result that the plant acquires strong growth and produces a heavy yield. If moisture is lacking or the soil is weak, the work goes on more slowly or for a shorter period. The lower leaves soon be-

come weak and inactive or they may die. The early closing of several workshops weakens the plant and results in a lessened crop and inferior quality of grain.

*The Heads or Spikes.* — These bear the fruit. The head or spike is composed of several parts. Furthermore, the heads of different kinds of wheat are unlike in form, length, size, and number of parts. They may be flattened, square, tapering, or club form. Some wheats have long awns or beards and in others the beards are of medium length, short, or nearly wanting. The appearance of the head is affected much by the position of the beards, whether parallel or spreading. Heads of beardless wheat appear smooth and easy to handle. Figure 4 shows these types of heads. Note how they differ.

FIG. 4. — Bearded and beardless wheat.

The head is made up principally of spikelets (Fig. 5). These are attached to the upper part of the stem, and contain first the flowers and later the kernels. The kernels are inclosed in scale-like coverings called "glumes," some of

which bear the beards. If there is an opportunity, we should observe heads of wheat, and count the spikelets, noting whether they are open, compact, or crowded in the head. Opening the spikelets, we should count the number of kernels

FIG. 5. — The upper end of a sphere (at the left) showing spikelets, glumes, beards, and kernels.

in each and see whether they are held in position firmly or loosely. Most wheats have two or three kernels in each spikelet.

*The Grain.* — The most useful product of the head is the grain. Do we know what a kernel or grain of wheat is like? Many people cannot tell it from rye or barley and some cannot tell it from corn.

Kernels of grain secured from the farm, elevator, or the mill will show the following: the oval form, the furrow or suture on the inner side, and the germ or embryo at the lower end (Fig. 6).

By cutting the kernels we can learn of their hardness. Some varieties are much harder than others, and so wheat is classified as *hard* or *soft* on the markets. Imperfect kernels are soft, light, and chaffy. Grain dealers call them unsound.

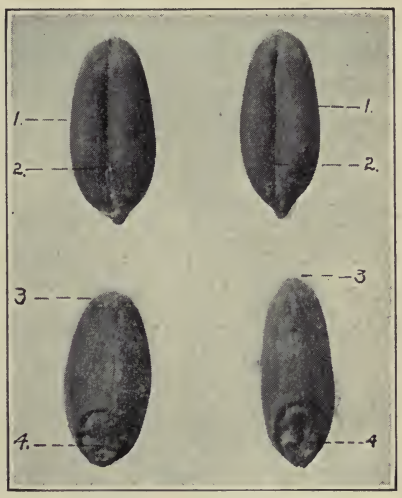



FIG. 6. — The wheat grain: *1*, cheek; *2*, suture; *3*, brush; *4*, embryo.

The natural colors of the grain are whitish, yellowish, reddish, or darker, depending on the variety and climate. The natural color is modified by rains and other weather conditions at harvest time.

**The Parts of the Kernel.** — The wheat kernel has three principal parts, the *coatings*, the *embryo*, and the starchy interior called the *endosperm*. We shall not fully describe these parts. Such a study belongs to a department of agriculture called *agronomy*. Our chief interest is in the

quality and use of the grain. What we have studied about the physiology of foods may help us to understand the meaning of such terms as cellulose, starch, sugar, fats and oils, and ash. All of these materials are in the wheat grain.

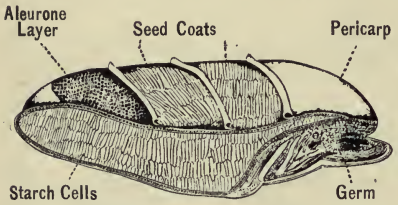



FIG. 7. — Diagram showing structure of wheat.

The kernel has several layers in its outer portion. The outer ones are composed principally of cellulose. They produce the *bran* in flour making. One of these layers contains considerable coloring matter. The bran layers make up about five per cent of the weight of the entire kernel.

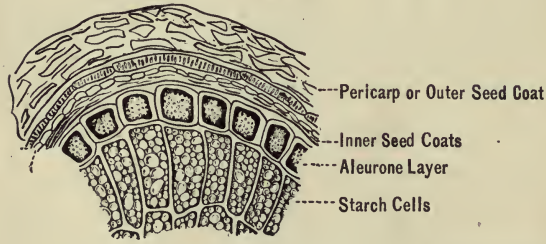



FIG. 8. — Highly magnified section of a portion of wheat grain.

Just inside the bran, between it and the endosperm, is the cereal or *aleurone* layer of large gluten cells. This division makes three to four per cent of the weight of the grain.

The starchy interior is eighty per cent or more of the weight of the kernel. Viewed under the microscope, it is shown to contain cells filled with starch grains. The cell walls are cellulose. Besides starch, which is the principal material in the cells of the endosperm, are protein, some oils, and a little sugar. The term *gluten*, so often used, is not a single substance. It includes two or more kinds of the protein. The gluten is important in wheat since it gives baking qualities to flour.

*Germ.* — The germ is a miniature plant ready to grow when it is planted. It is very appropriately called the embryo. This part of the seed is connected with the endosperm, from which it draws food supplies during germination. When man uses the grain for food he changes all this provision of nature. The food materials in the embryo are principally fats or oils, although there is also protein, sugar, and starch.

By weight, ten per cent or more of the wheat grain is water, though the amount varies greatly. There is also some ash in each part of the grain.

**The Kinds of Wheat.** — The various kinds of wheat represent to some extent the natural influences of the countries in which they have grown so long. Yet they have been greatly modified by man during recent years. The State Agricultural Colleges and Experiment Stations have by careful

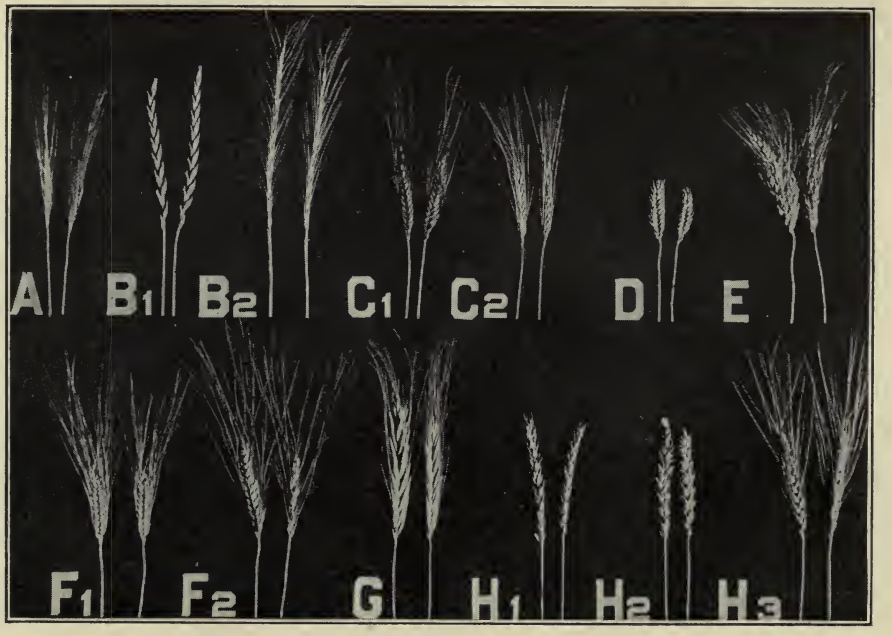



FIG. 9. — Types of wheat.

*A*, Einkorn; $B_1$, Beardless Spelt; $B_2$, Bearded Spelt; $C_1$, Emmer, Black Winter; $C_2$, Emmer, White Spring; *D*, Club Wheat, Little Club; *E*, Poulard, Alaska; $F_1$, White Durum; $F_2$, Black Durum; *G*, Polish Wheat; $H_1$, Common Wheat, Beardless Fife; $H_2$, Common Wheat, Beardless Blue Stem; $H_3$, Common Wheat, Bearded Turkey Red; $H_1$ and $H_2$ are spring wheats; $H_3$ is winter wheat. Not all spring wheats are beardless, nor are all winter wheats bearded.

selection, breeding, and cultivation developed desired qualities in many varieties. Scientists of our country have explored practically all wheat-growing regions of the world and collected seed for experimental work in the United States. In this way wheat has been carried from country to country and new varieties have been developed. We now have wheats better suited to the soil, climate, and seasons of the many regions. The grain has also been changed as to its food values, making it better suited for specific purposes. The wheat we see is fully domesticated. It could not survive if left alone. The old and unimproved varieties are of little value.

**The Types of Wheat.** — The following outline shows the eight divisions to which the 1000 and more varieties of cultivated wheat belong. They are called types (Fig. 9).

1. *Einkorn* is a very old type with one kernel in each spikelet. It has little importance.

2. *Spelt* is a dry land wheat cultivated mostly in Europe and used principally for stock feed.

3. *Emmer* has a compact, flat head bearing hard, reddish grain. It is a dry land wheat extensively grown in Russia. It is produced in the United States, where it is wrongly called spelt.

4. *Club Wheat*, so named because of its form, has a compact spike. Its short, stiff straw holds the grain remarkably well, making it resistant to lodging. The glumes likewise are stiff, do not open easily even when ripe, and thus tend

to keep the spikes from scattering and spilling the grain. This wheat is well suited for cultivation in the Rocky Mountain and Pacific Coast states where the grain is often allowed to stand for weeks after it is ripe before harvesting. The type is grown principally in Chile, Turkestan, Abyssinia, and in the western part of the United States.

FIG. 10. — Einkorn, close view. This is considered the most primitive of the wheats.

5. *Poulard Wheat* is drought and heat resistant. It is related to the durum varieties. It is raised for experimental purposes only in the United States, but has importance as a crop in Europe and Africa.

6. *Durum* or *Macaroni Wheat*, is adapted to regions of low rainfall. It is tall and vigorous with wide leaves, short, compact heads, and long beards. The large kernels are rich in gluten content. This wheat is used extensively in the manufacture of macaroni. It is grown widely in various foreign countries and has importance in the Great Plains Region of the United States and Canada.

7. *Polish Wheat* is known also by the names Giant Rye and Jerusalem Wheat. The grain is not very productive. It is rich in gluten and low in starch. The type is grown

principally in southern Europe and used in the manufacture of macaroni.

8. *Common Wheat* is the type of greatest commercial importance. It is grown in most wheat regions of the world. It ranks first because flour made from it is in greatest demand for bread making.

The number of varieties is very great. In some places they are merely classed as *soft*, *medium*, and *hard*. They are also known as *spring* and *winter* wheat. A fuller description of the kinds of wheat is made in connection with the discussion of the wheat-growing countries.

### Questions and Exercises

1. What is a plant?

2. Plant some wheat in a garden plot. If it is the winter season, plant a few kernels in a shallow box which may be kept in a window. Determine the length of time elapsing before the leaves appear. Study the plant as to root system, arrangement of leaves, and rate of growth.

3. (*a*) Why may leaves well be called workshops of the plant?

(*b*) What are the functions of the stem?

4. What part of the wheat kernel is of greatest importance for flour?

5. Through what agencies is the question of what wheats are best adapted to certain regions being determined?

6. Suggest a reason why Einkorn is so named.

7. Where is Club Wheat important? What are its advantages?

8. Where is Durum Wheat extensively grown? Why?

9. Why is Common Wheat of greatest importance from the standpoint of industry?

## CHAPTER III

## *CULTIVATION AND GROWTH*

The most ancient history of which we have any knowledge makes mention of wheat as a prominent food material. We know from this that it was one of the first grains to be cultivated. No one knows when it first became a domestic plant. Probably wild wheat found favor with prehistoric peoples because of its large kernels and agreeable taste. They may have thought of assisting the growth of the plant by crudely preparing the soil and scattering seeds and by keeping out other plants. In some such manner cultivation and domestication came about centuries ago. Since that time wheat has become so dependent on man for its very existence that if left uncared for, it could not survive. In its contest with other grasses and weeds, wheat would be crowded out and probably in a few years would almost completely disappear. But wheat is such a desirable article of human food that man helps it in its struggle with its rivals. The care given for the sake of promoting growth and insuring yield is

known as cultivation, and plants so grown are called the cultivated or domestic plants.

**The Cultivation of Wheat.** — Cultivation of wheat consists essentially of three processes, — preparation of the seed bed, seed selection, and planting. The crop is grown in many countries under diverse conditions of soil, climate, and even of people. It is interesting, therefore, to study the processes involved in wheat raising in our country and to compare our methods with those of foreign lands.

*Plowing the Soil.* — The first work in the preparation of the seed bed is to loosen the upper portion of the soil, usually to depths of from three to eight inches. The tool for this work varies from the crooked stick used by some of the savages or semicivilized peoples to that of the large tractor plows used on the Great Plains. A long-bladed hoe is still in use among isolated mountaineers in Switzerland, northwest Spain, and parts of Norway.

Even in fairly important wheat sections of Egypt, Asia Minor, and the Balkan States, some very crude plows are used. One-handled wooden plows with only a steel point are common in those districts. These plows are drawn by cattle, donkeys, or camels which work singly or in pairs and sometimes in peculiar combinations. For instance it is not an uncommon sight to see a farmer plow-

ing with a team consisting of a cow and a camel or a cow and a donkey. In the United States such teams would undoubtedly attract considerable attention.

The small steel walking plow with wooden

*Courtesy of International Harvester Co.*

FIG. 11. — Plowing in Egypt with cows and camel. Wooden plow.

handles is common in our own country only in regions of small fields. The use of this plow in wheat growing is confined almost entirely to the Eastern states. It cuts a furrow from twelve to sixteen inches wide and is usually drawn by two or three horses, the latter number always being used with the larger sized plow. But very little

wheat is grown in the United States for which the plowing is done by only one horse. This method is used only on small tracts in very hilly districts.

The single furrow riding plow predominates in the mixed farming portions of the Central states. There wheat is important, but is not the only

FIG. 12. — Plowing with the common two-bottom gang plow. Each cutting lay makes a twelve-inch furrow.

profitable crop. It has keen competitors in corn, oats, clover, and alfalfa. Land is high priced. For these various reasons fields are moderate in size, ranging usually from twenty to sixty acres each. Hence the riding plow, locally called the "*sulky*," seems to be best adapted to the farming conditions. It cuts a sixteen-inch furrow, runs on three wheels, and is pulled by three or four

*Photo by E. L. Currier, Montana Agricultural College*

FIG. 13. — A disc gang plow pulled by a tractor engine. Large gang plows are common in the extensive wheat regions of the High Plains.

horses. The driver rides, his chief work being to guide the horses and to so regulate the machine that it will plow at required depth. This is done by means of a lever within easy reach of the driver. In addition to the lever there is also a foot lift by means of which the plow may be raised entirely out of the ground. The foot lift is convenient in turning at the end of the field because then both hands are busy with the lines, guiding the horses. Three or four acres is considered a fair day's work with this outfit.

Where large wheat fields prevail, as on the High Plains from Texas to Canada and in some parts of California, Oregon, and Washington, gang plows are used extensively. From two to sixteen plows are built on one frame, the whole being referred to as a two-bottom or sixteen-bottom plow. The two, three, or four bottom plows are usually drawn by horses or mules, while, with the larger sizes, either steam, gasoline, or kerosene tractors are used. In the corn belt from Ohio to Nebraska, where wheat is an important crop, the two-bottom gang plow is quite common. It is pulled by five or six horses, driven by one man, who considers five or six acres a good day's work. In the High Plains country west of this region ten to sixteen bottom plows drawn by great tractors are a common sight. There, over large areas, the wiry, panting cowboy's pony has been supplanted

by the ponderous, puffing, iron horse. The large gang plows also predominate in the great unirrigated wheat districts of California, Oregon, Washington, and Idaho. Wherever irrigation is practiced the fields are smaller and so large plows have not generally proved economical.

The type of plow used varies somewhat with the soil. It generally consists of a cutting edge termed a *lay* or *share* and a *moldboard*. The work is done by cutting under and turning over the soil to whatever depth is desired, ordinarily from four to eight inches. The moldboard type of plow is used in regions of clay or sandy clay soils and of fairly heavy rainfall. In regions where the soil is more sandy and quite dry at plowing time, another type called the *disc* plow is extensively used.

The disc plow cuts downward with a rolling motion, pushes the soil to the side, and partly turns it (Fig. 14). This machine has the advantage of doing its work somewhat more easily than the common moldboard plow but is not as well adapted to all conditions. Its most extensive use in the United States is in California and the states of the Northwest, though it is used to some extent in the Central states.

*The Time of Plowing.* — Autumn is the time when the greater part of the plowing for wheat is done. In winter wheat districts, this is of course

necessary, and the plowman is impatient to have the field cleared of the previous crop so that he may do his work early. Careful studies seem to show that early plowing is favorable to the best yield for the succeeding year. It conserves moisture and provides a better packed seed bed.

FIG. 14. — The disc plow. Instead of moldboards and lays, large discs are used to cut and turn the soil. Some farmers prefer this kind.

In spring wheat districts, the ground is usually plowed in the fall because the wheat needs to be sown as early in the spring as possible. This is particularly true where the growing season is short as in Minnesota or the Dakotas. There the seeding is done as soon as the ground is free from frost. The soil is well ventilated by the

plowing and then settles during the winter so that a compact bed is provided for spring seeding. There are some places of longer growing season and heavier soil, where spring plowing is in high favor.

*The Preparation of the Seed Bed without Plowing.* — In the corn belt region some farmers sow spring wheat in old corn fields without using the plow at all. In such cases the soil is stirred by means of a cultivator or disc harrow. Generally where this is practiced a quick rotation of crops is desired and spring wheat is thought to pay better than oats.

Winter wheat is raised in some localities without the use of the plow. In the corn belt the wheat is sometimes planted by a five-hoe drill between the corn rows. There is no special preparation other than that furnished by the drill. The ground has been prepared by the cultivation of the corn. This is possible only where the fields are free from weeds, where the stalks have not been blown down to any great extent, and where the soil is quite mellow. It is not a method in universal use nor one that can be depended upon in a given locality. In some instances the corn is cut and shocked as fodder and the wheat sown in the vacated field without special preparation. Where the ground is weedy or the soil not loose enough for a seed bed, the

field is stirred with a shovel cultivator and tooth harrow or with a disc harrow. The practice of sowing winter wheat in corn fields is, however, limited. Generally the yield is not so good as on plowed ground. Its advantage lies in furnishing a quick change from corn to wheat, both profitable crops, without using the usual connecting link,

FIG. 15. — Harrowing, the final process in preparing the soil for sowing. In many cases, the driver walks behind the harrow instead of riding upon it as shown here.

oats, which, in many instances, has not proved to be profitable.

Another plowless method of seed-bed preparation is employed quite extensively in the High Plains region where wheat is grown on the same ground several years in succession. Instead of plowing, the soil is merely stirred with the disc harrow. Usually the field is double harrowed,

the second time at right angles to the first. Generally speaking, this method is used only where the soil is light and the rainfall scant. As a rule even in such regions the land is plowed every other year.

*Harrowing the Soil.* — After plowing, the land is smoothed down, the clods pulverized, and the

FIG. 16. — Harrowing the ground before drilling the wheat. This harrow, drawn by five horses, takes a strip twenty feet wide.

soil packed to some extent. This is accomplished by harrowing. The harrow is commonly of the toothed type; that is, iron spikes set in pipes or bars (Fig. 16). The size of the harrow varies from the small one-section four-foot width, drawn by one horse, to the four-section twenty-foot width, pulled by five horses. With the larger outfit one man and a team can cover 60 acres in a

day and, with the smaller, five acres is a good day's work. Usually in the wheat belts of our country the harrow used is the three-section 18-foot width, drawn by four horses. Ofttimes a two-wheeled cart is attached to the rear of the harrow or a seat is arranged on top to furnish riding

FIG. 17. — Discing the plowed ground. This cuts and crushes the clods, and assists in preparing a good seed bed.

accommodations for the driver. Sometimes an extra horse is used on which the driver rides. More often, however, the harrowing is done by boys who walk behind the machine. This method is widely employed where the small one-horse or two-horse harrows are used.

In the corn belt area of the wheat section,

where several weeks intervene between plowing and seeding, heavy rains and luxuriant weed growth necessitate more vigorous stirring of the top soil. This calls for the use of the disc harrow prior to that of the tooth harrow. Where this is the case the harrowing is usually delayed until about seeding time. This is in contrast to the

FIG. 18. — A field ready to be seeded to wheat. Note the smooth seed bed.

method followed in the drier districts, where harrowing follows soon after plowing, often the same day. In some cases it is even accomplished by a small harrow attached to the plow. In this way clods are immediately crushed and a loose surface mulch provided which assists in retaining moisture. This is a great advantage where rainfall is likely to be deficient. It is, however, a

disadvantage where heavy rains occur, for in such case a smooth crusted surface results which is difficult to pulverize and prepare into a suitable seed bed. Thus we see how closely man's activities even in this small detail are related to climatic conditions.

**Methods of Seeding.** — Two processes are involved in planting the grain : sowing and covering. These processes may or may not be performed by the same machine. Where seed is scattered rather evenly over the ground, the process is known as *broadcasting;* where the seed is sown in rows the method is termed *drilling.*

In most places where wheat is grown only in small tracts, the seed is sown by hand. The sower usually holds a bag of seed on his left arm and scatters the grain with his right hand (Fig. 19). Sometimes he carries the seed in a trough-like box hung from his shoulders, leaving both hands free to use in scattering the seed. Sowing, then, consists in " casting abroad," which has given rise to the term *broadcast.* Considerable skill is necessary to scatter the seed evenly, and the worker presents a pleasing sight as he advances with measured tread and rhythmic swing. This scene furnished the inspiration for Millet's famous painting, The Sower.

Wherever wheat is grown on a larger scale, machine seeding is employed. The broadcast

methods may be in this case done by machinery. Small hand machines like those used in sowing grass seed or machines fastened to wagons and driven by power transmitted from the turning wheels are often employed. This latter type is known as the end-gate seeder and was formerly used extensively for sowing spring wheat in old

FIG. 19. — Sowing by hand. A method now used only for small fields or where primitive agricultural methods are still employed.

corn fields. The common broadcast seeder, a separate machine drawn by horse power, consists of a hopper connected with a series of scattering devices which spread the seed evenly over the ground. Such a machine is of light draft and is made in various widths from eight to twenty-four feet.

Wherever broadcast sowing is practiced, some method of covering must be employed. In plowed ground this is done with the common harrow. For corn fields or for firmly packed soil, the shovel cultivator or disc harrow is employed. This is

FIG. 20. — Sowing wheat with a press drill. Some press drills are so made that the weight of the machine is carried on the rear wheels, hence no side wheels are necessary.

followed by the common tooth harrow for leveling the land.

Drilling is more general than broadcast sowing in the great wheat districts of the United States.

Wheat drills are of three general types: *Hoe drills*, *shoe* or *runner drills*, and *disc drills*. The

hoe drill consists of a series of small shovels which open the ground to permit a stream of wheat to be introduced just back of them so that the soil settles back in place covering the seed. This form of drill is well adapted to heavy soils which are naturally inclined to pack closely. For more friable soils the furrow is usually opened by means of a runner or disc, either single or double. The seed is introduced just behind the furrow opener and the furrow is closed by a wheel which follows and compacts the soil. The pressure is applied either by a spring on the wheel or is caused by the weight of the machine resting on the rear wheels (Fig. 20). These machines are known as *press drills* and are extensively used in the districts of sandy or friable soils. They have proved of great value in furnishing carefully prepared, compacted seed beds for a large part of the great wheat-producing area of the West. They seem to be the kind best adapted to the soils in which wheat thrives best.

*Time of Sowing.* — The best time for sowing wheat varies with so many factors that it is difficult to state any general rule. For winter wheat districts, early seeding prevails in the northern parts; late, in the southern. The sowing must be early enough to give time for a fairly sturdy growth, otherwise the wheat is unable to withstand winter hardships. There is also a dan-

ger of too early seeding in that the growth becomes so rank that it lessens the powers of resistance, and, in many cases, exposes the wheat to the ravages of the Hessian fly. Inasmuch as the proper growth is the thing desired, it is readily seen that the factors which promote growth also make late seeding possible. Hence later sowing

*Courtesy International Harvester Co.*

FIG. 21. — A large size modern drill.

can be more profitably practiced in fertile soils than in soils less fertile; in carefully prepared ground than where poor seed bed is provided; and where moisture is ample than where it is somewhat scarce. For the wheat belt in the neighborhood of latitude 40° north and from altitudes of 500 to 1000 feet, the most favorable time for sowing is from September 10 to 20.

North of that the sowing time is earlier; to the south it is later, even as late as November in some cases.

In general where spring wheat is raised, it is best to sow it as early as possible. Seeding time then necessarily comes later to the northward. March sowing is not uncommon in Nebraska and Iowa, and in some of the Canadian provinces sowing is not finished before May 25. Though these dates apply to our own country, we shall later learn that seeding is going on somewhere during every month of the year.

**Cultivation after Sowing.** — Usually no cultivation is necessary. Man contributes his influence in preparing the seed bed and in planting. Once placed on a secure footing, wheat is able to overcome plant competitors and weeding is unnecessary. In that respect it is stronger than corn, for it covers the ground early in its life history. Harrowing winter wheat in the spring is sometimes tried, but the advantage of such work is problematical. Where the upper soil has formed a hard crust, harrowing may prove beneficial because it loosens the soil and conserves moisture. Generally speaking, the injury to a large number of wheat plants must be considered carefully when we judge the value of such work. Where the soil is very loose, rolling winter wheat in the spring has been found profitable. Pastur-

ing winter wheat in very early spring is also claimed to help compact the soil without injuring the wheat plant. This practice must be carefully watched, however, so that it is not permitted when the ground is too soft or that it may not be continued too late in the spring. As a general rule wheat receives no further labor after seeding until time of harvest.

**The Growth of Wheat.** — Though wheat is not cultivated after planting as is corn, still it receives much attention. In the autumn the farmer watches its growth with interest. The wheat comes up in a week or ten days after seeding if the weather and soil conditions are favorable. Winter wheat grows to be a small grassy plant before the ground freezes; and the fields viewed from a distance appear green. If the fall growth is good, an extensive root system is developed and the plant will likely survive the winter. The greatest danger lies in a very dry autumn, which prevents the proper growth, or in the presence of the Hessian fly. This latter is a small insect which attacks the wheat plant near the base, causing the leaves and stem to turn yellow and die. While it works some damage in the autumn, a more serious menace lies in the fact that the mature insects are developed at this time. When these insects infest the wheat field, there is grave danger of their becoming so numerous the next

spring that they will ruin the crop (see Figs. 60 and 61). Some farmers sow a "catch crop," a strip of early sowing around the field. When this strip has become infested with the fly, the ground is plowed, and in this way the insect is killed. The main field, sowed later, is thus in a measure protected.

The wheat plant remains green late into the winter. Before spring, however, the older leaves have turned brown and sometimes in late winter the field may show practically no evidence of life. Then the farmer is anxious. He fears that his wheat has been winter killed. He probably expresses his fears to others. Reporters hear the rumors and express the same feelings through their papers. Soon the price of wheat rises on the market as a result of these "bear" stories. In a short time spring opens. The weather turns warmer, the snows melt, and the rains come. Then with a rapidity almost startling the brown field changes to green. The farmer watches for even coloring, for he wants no bare spots in the field. Sometimes because of insufficient rainfall or drifting snow, parts of the field will come through the winter better than others. But with favorable conditions the even stand which results brings joy to the farmer's heart.

The winter crisis has passed. The spring growth is well started. If spring wheat is sown, it soon

comes up and henceforth passes through the same stages and meets the same dangers as does the winter wheat. In the spring the farmer wishes for plenty of rain, for this is the growing season. He realizes that several dangers are still to be passed before his crop can be considered safe. Drought and hailstorms are feared. Where irrigation is practiced the water is applied freely, and the farmer feels that he has overcome the greatest obstacle to success in that region. But, since irrigation is more costly than is natural rainfall, the expense of production is higher. But with favorable weather and moisture either by rain or by irrigation, good growth is assured. The field looks like a well-grassed meadow. The stems are growing rapidly, the wheat is soon ready to '*head out.*' This is a critical period, for a year's crop is at stake. Do you wonder that, if it is becoming *dry*, the farmer looks anxiously for the rain clouds to appear? He fears the hot winds which may come and literally dry up his wheat in the field. When clouds do appear he watches them intently. Even then the danger is not past. In many sections hailstorms or severe winds may come which will ruin a crop in less than an hour. The farmer visits his field frequently at this time for now it is that the Hessian fly may reappear. He looks in the field for broken straws which indicate the pres-

ence of this pest. He examines many stalks at the places where the leaves join the stem. This is the favorite position for the fly to get its nourishment from the wheat plant when it is approaching the *flaxseed* stage. If the season is dry, the chinch bug is also to be feared. The losses caused by the chinch bug to the wheat growers of the Mississippi valley have in some years amounted to many millions of dollars.

Fortunately fairly effective methods of fighting these pests have been discovered and farmers do not now feel as helpless as they formerly did. These problems and difficulties must be mastered by the wheat growers if they are to succeed. Thus we can readily see that wheat farmers must be thinkers, men of brains as well as men of brawn.

But the season advances. The dangers are passed one after another. Rainfall has been sufficient. The wheat *heads out*, passes through its blossoming period unnoticed, for it is a self fertilizing plant, and finally forms the seeds, the grain, in the heads. When they first reach a fairly good size they are plump and soft and are filled with a milky fluid. Then they become solid, though not hard. The plant loses its green coloring and the field changes slowly to lighter hues. At last comes the golden yellow which marks readiness for harvest. The period of growth is ended and the period of reaping is at hand. The

appearance of the field now is difficult to picture in words. The color is rich golden, and the gentle winds sway the stems into billows which resemble those of the sea. No more inspiring scene can be found than that offered by the wheat fields at

FIG. 22. — Alongside a wheat field. It is nearly ready for harvest.

harvest time. For miles and miles, they undulate over hills and valleys or stretch out like a blanket over the level plains.

The farmers are happy, but they are not alone in their happiness. Business in general quickens

with the touch of prosperity offered by the assured wheat crop.

### Questions and Exercises

1. Why do we speak of wheat as a *domestic* plant?
2. Of what does cultivation of wheat consist? Explain how this is of assistance to the plant.
3. What is the purpose of plowing?
4. Suggest reasons why the moldboard plow is more generally used than the disc plow. Which is the more widely used in your locality? Why?
5. How may the preparation of the seed bed be accomplished without plowing?
6. What is the purpose of harrowing?
7. Under what conditions is it wise to harrow immediately after plowing?
8. What methods of wheat sowing are in general use in your vicinity?
9. How does the amount of cultivation given wheat compare with that given corn? Suggest reasons for this difference.
10. What are the enemies and dangers encountered by wheat before it is ready for harvest?
11. Write a brief story of the cultivation and growth of wheat in your home region. Let your story include methods of plowing, harrowing, sowing, and kinds of wheat raised.

# CHAPTER IV

## *HARVESTING*

**The Methods of Harvesting.** — The harvest consists of cutting the wheat as it stands in the field and bringing it together as bundles, shocks, or stacks. This still requires both hand and machine work, although the amount of hand work has been very greatly reduced by the use of modern machinery. There has been a gradual development in the methods of harvesting until at present it involves the use of the most complex agricultural implements made. Primitive methods, however, are still followed in some places. Because of this fact, the following machines are all now used in the harvest of the world's wheat crop: sickle, cradle, reaper, binder, header, and harvester-thresher or "combine."

*The Sickle and the Cradle.* — The *sickle* is used in the small fields of parts of Palestine, northern Spain, Norway, on some of the small islands bordering Great Britain, and in other isolated districts. It consists of a curved knife fastened to a short handle and resembles the small sickles used

in trimming corners of lawns. The laborer usually grasps a handful of the wheat in his left hand and cuts it with the sickle held in his right. The cut wheat is then laid in well arranged bunches to be bound later, usually by women or children. This method is slow and difficult and is now employed

*Courtesy International Harvester Co.*

FIG. 23. — Harvesting wheat with a sickle.

only in very remote places. The *cradle*, an implement somewhat less primitive, is used in cutting the wheat of larger fields in the same regions where the sickle is in use, and also in some of the more hilly sections of our own country. It resembles a scythe but has arms above the cutting

edge to assist in keeping the grain well arranged. Much skill is necessary in handling a cradle so that the swath may be even and that the grain may be left in bunches which can easily be bound into bundles. Two or three acres makes a hard

FIG. 24. — Harvesting wheat with a cradle.

day's work for one man. The most skillful cradler is the harvest hero in communities where the wheat cradle rules. The work of binding the grain is often done by young boys or women. The bunches are gathered and arranged into

bundles of a size convenient for handling. The worker then takes a handful of the straw, and, by a double turn movement, twists the heads together and locks them. This movement forms a straw band nearly twice as long as a single wheat plant. This band is passed around the bunch of grain and drawn tight. The ends are then twisted together and fastened by pushing them under the band. The wheat bundle thus formed is called a sheaf. These sheaves are then set in groups called shocks and are left standing in order to become thoroughly dry. Skillful binders can make beautiful sheaves. The term *self-binder* later became applied to machines which did this work. Still later the term became shortened to the *binder* as we have it now. Generally the only hand binding done in our country is that of the occasional bundle which the binder misses. For this reason in the larger wheat sections the hand-bound sheaves are not always perfect (Fig. 25).

FIG. 25. — A hand-bound wheat sheaf. Binding grain by hand is becoming a lost art in the wheat regions.

*Modern Machines.* — Both the sickle and the cradle have been displaced in all but the smaller

places by the larger harvesting machinery. The machines used where wheat is produced in commercial quantities are the reaper, self-binder, header, and the combined harvester-thresher. These have several essential things in common. In each, the cutting device consists of a number of triangular sections, two sides of which are ground to knife edge and serrated. These are then fastened to a bar in the manner of saw teeth. This whole device is known as the grain sickle. This sickle moves rapidly back and forth through stationary guards as the machine is drawn through the field, and the grain is held against the sickle by a reel or set of rakes. As it is cut the grain falls upon the platform with straw parallel. The power for this work is derived from the turning of a large wheel, known as the master wheel, on which the greater part of the weight of the machine rests. The sickle can be raised or lowered while in motion by a lever so placed as to be within easy reach of the driver. The swath to be cut is separated from the remainder of the field by a grain point so that no grain is run down or broken.

The above outlined essentials are common to all grain-harvesting machines. Marked differences are found, however, in working out the details of their operation.

*The Reaper.* — This term is used to define a

harvesting machine which cuts the grain, gathers it into loose bunches which can be dropped in cross rows called windrows. In some cases these bunches are bound by hand, in others they are stacked without binding. The machine is quite light, cuts a swath about four and a half feet wide,

FIG. 26. — Harvesting wheat with a reaper.

and is pulled by two or three horses. The size of the machine and its light weight make it well adapted to fields of small size, of irregular shape, or of steep slope. Hence the use of the reaper as a wheat-harvesting machine is limited in this country to the hilly lands of the Eastern states. In the wheat harvest of the central plains or the

Western states, where the fields are large and the topography gentle, very few reapers are in use.

*The Binder.* — By far the greater part of all small grain, including wheat, is harvested by the self-binder. The grain is held against the cutter bar by means of a reel whose motion deposits the cut grain on the platform canvas by which it is conveyed to the elevator. The elevator, consisting of two endless canvases, one above the other, carries the grain between them and deposits it on the opposite side of the master wheel, where it is caught by steel-arm packers, made into a trim bundle, and bound with twine.

The twine used is a coarse twisted cord made from the fiber of hemp, flax, or sisal. The hemp twine is more extensively used than that made from any other material. The cost of the twine is from ten to twelve cents per pound and it takes about one pound of twine for each ten bushels yield although this varies with seasons. The binding apparatus operates as soon as released by the pressure of the bundle against a trip. Hence the size of the bundle may be regulated by increasing or decreasing the amount of pressure required to trip the binder. The knotter is one of the most ingenious devices imaginable. It makes a knot which is very difficult to untie. As soon as the bundle is tied, a knife cuts the twine, the bundle is thrown out by a couple of iron arms known as

FIG. 27. — Harvesting wheat with a binder (front view).

FIG. 28. — Harvesting wheat with a binder (rear view).

*kickers* and is deposited on a bundle carrier fastened low at the side of the machine. The carrier can hold four or five bundles and is operated by the driver, who with his foot handles it so as to dump the bundles into rows for convenience in shocking.

Binders are made in different sizes, usually cutting swaths six, seven, or eight feet wide. The smaller machines are drawn by three horses, the larger ones by four or five. In some cases a gasoline engine which does the work of operating the machinery is attached at the rear part of the binder. In this case the horses merely pull the machine over the field. This is especially advantageous when the ground is so soft that it is difficult for the drive wheel to secure footing. The driver occupies a seat well back on the machine where he can watch all the working parts, and at the same time keep the horses moving at a uniform gait. After the grain is cut and bound, it is shocked. This is usually done immediately by one or two men whose work is to follow the binder. The bundles are set heads up in pairs or in round shocks. There are usually ten to twenty

FIG. 29. — A wheat sheaf bound by a self-binder.

bundles in a shock. Where rain is frequent and winds are not strong, one or two bundles are placed on top of the shock as *cap sheaves*. This is not generally followed in the West because rains are not so likely to occur and there is more wind. There cap sheaves are very likely to be blown from the shock.

FIG. 30. — A "windrow" of unshocked bundles. Shocks are shown in the distance.

The binder is adapted to a greater variety of conditions than other harvesters and it is also the machine best adapted to conditions prevalent in the wheat-growing regions. This accounts for its wide use. A binder costs the farmer from $140 to $160 completely equipped, and, if properly cared for, should last ten years or longer. Many

machines, however, due to excessive use or careless handling, last only from three to five years. Different makes of binders vary in details; some have minor advantages; but all are pretty well standardized in essentials.

After the grain is shocked it is left standing in

FIG. 31. — Beginning the shock.

the field until it is thoroughly dry. It is then either stacked or threshed.

*The Header.* — Very different from the above is the header. Like the reaper, it delivers the grain unbound, but it neither bunches nor keeps it suitably arranged for binding, as does the former machine. The header cuts a swath, usually ten or twelve feet in width, and is moved by

the power of four or six horses applied at the rear of the machine. The back part of the machine, where the driver stands, is supported by a wheel which can be turned by him at will. Thus he steers the course of the header through the field much as a pilot steers a boat by means of the rudder. The grain is cut to leave a high stubble in order that there will be no more straw than is necessary to handle. This tendency to clip the heads of the wheat has given the name to the machine.

FIG. 32. — Boys sometimes assist in shocking wheat.

When cut, the grain falls upon a moving platform canvas which conveys it to the spout where it is caught between the upper and lower elevator canvases. By these it is delivered to a specially prepared rack. This rack, unlike a hayrack, is usually boarded solid, with one side much lower than the other. This is known as a header box. The header box drawn by a team is kept even with the header; and

the grain is cared for by a man known as the loader, who later pitches the grain into the stack. The racks or header boxes are often driven by young boys, since there is no hard work involved. In some cases the grain is then unloaded into small bunches or shocks but generally it is at

FIG. 33. — The completed shock. A typical illustration of the round shocks without cap sheaves.

once made into rectangular shaped stacks. These stacks are from 16 to 48 feet long and two or four of them in a group are known as a *setting*. In some cases where the wheat is very dry it is threshed directly from the header box. This requires four or six headers at work in the same field.

The use of the header in harvesting is rapid

and involves a minimum of hard labor. It is practical, however, only where the grain can be allowed to stand until dead ripe, where it ripens evenly and is free from weeds, and where rainless harvests are expected. It is a method employed extensively in regions where wheat grows so short that binding is impossible. This condition we find frequently occurring in parts of the western Great Plains.

*The Combined Harvester-Thresher.* — In the extensive Sacramento valley of California and on the plains of Washington and Oregon, a thresher is combined with the header or binder into one machine. The machine cuts a wider swath, 18 to 30 feet, and the cut wheat is elevated into the front end of the threshing mechanism. This combined machine is pulled by 28 to 36 horses or mules, or by a large tractor engine. The straw is scattered over the field and the grain is put up in bags. From four to six men constitute a working gang, and an outfit can cut, thresh, and bag from 500 to more than 1000 bushels per day.

These machines, called *combines*, are adapted only to districts which are free from harvest rains, and in which fields are large. In some of the regions mentioned they are gradually disappearing because the extensive wheat ranches are being divided into smaller units and farming is becoming more intensive.

*Stacking the Wheat.* — Throughout the more humid wheat-growing districts, much of the wheat is stacked before threshing. This is because it has not been considered economical to have machines enough in the community to thresh all the wheat promptly when dry. So

FIG. 34. — Loading wheat bundles into the rack to be hauled to the stack.

while some thresh *out of shock*, many others stack their grain rather than to wait several days or weeks for a threshing machine. They know that during this wait their yield may be impaired both in quantity and quality by rain.

The stacks are made by arranging the bundles so as to protect the heads and shed the rain. Hence in stacking, the butts of the bundles are

placed outward and the central part of the stack kept high. This gives the straw an outward and downward slant. The shape of the stack may be round or rectangular and it is made as high as a man can conveniently pitch the bundles from a rack, usually 24 to 30 feet. Stacking is hard work both for the one who pitches the bundles

FIG. 35. — Stacking wheat in the field.

and for the stacker. The straw is dry, usually the sky is cloudless, and the air quite calm. With the thermometer standing between 90 and 100 degrees in the shade the worker is likely to feel that shock threshing after all would have been preferable. But when after a few days a heavy rain falls, he realizes that his grain in the stack is much better protected than that of his neighbor who left his in shock waiting for the thresher.

Shocks standing in the field for a considerable time are likely to suffer from wind and rain. Sheaves which have been blown down and are left lying on the ground, if rained upon do not dry out promptly. The wheat kernels are then likely to sprout and become damaged. Prolonged wet weather may

FIG. 36. — Stacking wheat in the farmyard. Pitching bundles to the top of a nearly finished stack is hard work.

even cause the wheat to sprout in the shock, which injures it both in weight and quality. Prompt stacking thus protects against exposure and resulting losses. Many farmers even claim that stacked grain improves in quality.

Soon after being stacked the wheat goes into

*sweat*, a moist condition which dries out in the course of three or four weeks. Grain thus cured is less likely to suffer or spoil in storage.

*The Date of Harvesting.* — In most places wheat is cut as soon as it is ripe or nearly ripe. The proper time is usually considered to be when the wheat grain is hard enough not to be crushed

FIG. 37. — A shock after standing in the field for several weeks. Note the bundles that have been blown down.

between the fingers, yet may be indented by the thumb nail. Generally the culm is still a little green and not thoroughly dry. This time marks the opening of vigorous activities, for the grower is anxious to have his grain in the sheaf or stack as soon as the work can be done without injury to the grain. If it is allowed to become overripe there is thought to be some slight loss in weight,

and there is undoubtedly considerable loss from shattering and spilling in the field. There is also prolonged danger of loss due to storms. Hence, when once started in a given field, the work of harvesting continues with but little interruption until completed. Holidays are forgotten and long

FIG. 38. — In some places it is customary to bring lunch to the harvest workers.

hours are observed, fourteen working hours a day being common. Where the harvest comes early in July, Fourth of July celebrations are neglected or limited to evening festivities. Many people even work Sundays, regarding the wheat harvest as a type of necessary labor that can be performed without breaking the spirit of the Sabbath.

In those sections where the season is rainless,

as in parts of California and Spain, the harvest is prolonged and not marked by any great haste. Since the kind of wheat grown, club type, does not shatter nor lodge readily, it is allowed to stand for weeks after ripening. The grower in such places takes holidays at his pleasure and is not worried over possible losses. Needless to add, there festal occasions and Sundays are diligently observed.

Wheat is being harvested somewhere all the time. The United States Crop Reporter presents the following interesting table, which shows the time succession in the harvest of the world's wheat crop. Note where your state belongs and what countries harvest at the same time. Also note where the harvest is in full swing at the time you are reading this.

*January:* Chile, New Zealand, Australia.
*February and March:* Upper Egypt, India.
*April:* Lower Egypt, India, Persia, Asia Minor, Cuba, Mexico.
*May:* Texas, Algeria, Morocco, China, Japan.
*June:* California, Utah, Oklahoma, Kansas, Arkansas, Missouri, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Virginia, Kentucky, Tennessee, Spain, Southern France, Italy, Greece, and Turkey.
*July:* Washington, Oregon, Wyoming, Nebraska, Iowa, Southern Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, New York, New England, Southern England, Germany, Southern Russia.

*August:* Montana, the Dakotas, Central and Northern Minnesota, Canada, England, Belgium, Netherlands, Central Russia.

*September and October:* Parts of Western Canada, Scotland, Scandinavia, Northern Russia.

*November:* South Africa, Peru, Northern Argentina.

*December:* New South Wales, Burmah, Argentina.

Thus it is seen that the wheat harvest in the United States begins in Texas in May and ends in the Dakotas in August. All through this season the hum of the harvester measures prosperity to a great section of our country. For as soon as the wheat is cut it can be used as the basis of credit. Money can be secured by loans if the owner does not care to sell. When the wheat is cut, the income from it is fairly certain, as there is then but slight chance of failure to secure the grain, the wheat of commerce. Only one great process in production remains to be accomplished. It is that of threshing.

### Questions and Exercises

1. Suggest conditions in which sickles or cradles would be the tools best adapted to the wheat harvest.

2. What are the essential parts common to different harvesting machines?

3. To what wheat field conditions is the reaper well adapted?

4. How did the term *binder* come to be applied to the machine of that name?

5. What makes of binders are in favor in your locality? Where are they manufactured? If several makes are in use, it is interesting to study how they differ.

6. Why are wheat bundles shocked?

7. By inquiry try to learn how many acres one man can shock in a day. What wages are generally paid for this work?

8. What are the essential differences between a binder and a header?

9. What is the advantage of leaving a high stubble in cutting wheat?

10. Why are *combines* used so extensively in parts of California, Oregon, and Washington?

11. Discuss the advantages and disadvantages of stacking wheat. Is this plan generally practiced in your part of the country?

12. (*a*) Why does the harvest occur in Argentina in December and January?

(*b*) Explain why the wheat harvest occurs in Texas in early June, and in Canada it occurs in August.

13. What rainfall conditions are preferable during the harvest season? Why?

14. If you live in a wheat-growing locality, endeavor to determine the cost per acre of harvesting. This will, of course, involve the cutting, twine, shocking, and stacking.

# CHAPTER V

## *THRESHING*

**The Methods of Threshing.** — The purpose in threshing is to separate the grain from the straw. The wheat of the harvest is left, as we have learned, either loose or bound. If the binder is used, the bundles are in shocks or in stacks; if the header is used, the product is stacked without binding. In either case the grain is still in the heads, with each kernel wrapped in its glumes. The harvest product is largely straw as to bulk. Several distinct processes are involved in obtaining the grain, but they are all included under the name threshing. The products of threshing are the wheat grain and the straw. The latter consists of the stems, leaves, and the chaff which is made up of glumes, beards, and small bits of other parts of the plant. The work of separating these products is accomplished in several ways as we are to learn.

*Primitive Methods.* — When man first began to use wheat he probably extracted the kernels by hand, rubbing or crushing the heads between his

palms or fingers, and blowing away the light fine stuff, the chaff. From the suggestions afforded by this very primitive method grew the use of sticks to beat the grain out of the heads and the use of the wind to carry away the chaff. This method is still preserved to us in some places by the use of the flail.

FIG. 39. — Threshing with a flail.

*The Flail.* — The flail consists of a short strong stick, used as a handle, to which another heavy stick is fastened by means of a piece of strong rawhide or rope. Striking a bunch of wheat with this device shatters the spikes and causes the grain to sift through to the floor. The chaff is removed by dropping the mixed grain and chaff in a draft of wind. Threshing by this method is

hard, tedious labor. Eight to ten bushels is considered a good day's work. It is used only in places remote from trade routes, where fields are small and civilization is not very complex.

FIG. 40. — The threshing floor.

*The Threshing Floor.* — The simplest form of power threshing is where the wheat is spread over the hard ground or upon a board or stone floor

specially prepared for the purpose, and cattle or mules are driven over it. The hoofs of the animals crush out the grain by repeatedly stepping on the heads. In some cases a crude sled is dragged over the wheat in order to assist in the shattering process. By means of the hands or a fork, the mixed straw, chaff, and grain are then thrown into the air when a breeze is blowing. The separation is accomplished by the settling of the heavy grain first and by the blowing a little farther on of the lighter parts. This method is called *winnowing* and is used extensively in Asia Minor, in parts of Palestine and Egypt, and to some extent in many other countries. Although this method is faster and less laborious than the flail, it is too slow and takes too much hand labor to compete with modern methods. For this reason it is not adapted to the needs of extensive wheat-growing regions.

*The Thresher.* — The principle of the modern threshing machine is the same as that of the early types just described. Its function is to shatter the spike and separate the wheat grain from the straw and chaff. Machines of this type were not introduced until 1800 and did not come into general use in our country until about 1840.

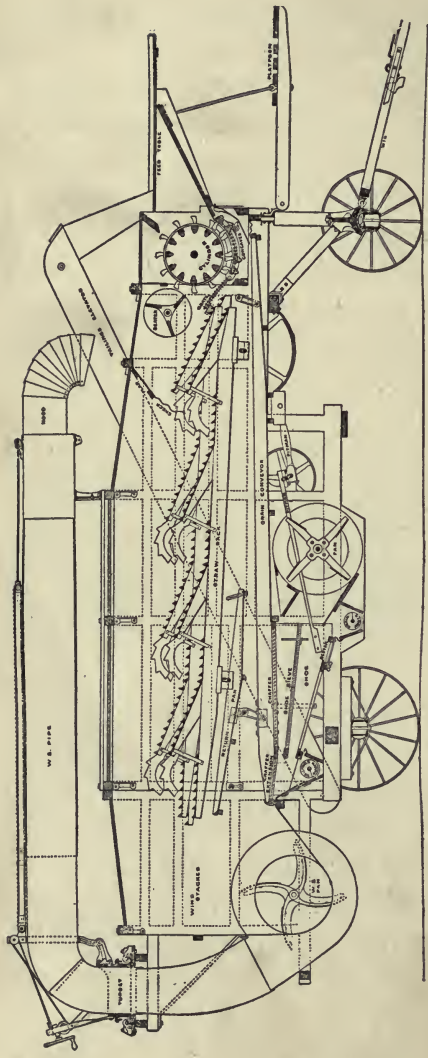
The modern thresher has added several attachments so that now the complete machine consists

of a self-feeder, band cutter, thresher, separator, straw stacker, grain elevator, and weigher.

The sheaves are pitched upon the self-feeder; and this carries them to the band cutters which cut the twine, and thence to the shakers which loosen the straw and feed it into the cylinder. There the straw passes between the rapidly rotating cylinder and the stationary concave, which

FIG. 41. — General view of threshing out of shock.

are both set with teeth. These teeth thoroughly shatter the spikes and loosen the grain. When it has passed the cylinder, the straw is pounded by a set of beaters which shake it up. It then hits a deflecting board or canvas causing it to fall upon a set of slatted racks. These racks have a violent motion up and down as well as back and forth. This work is to shake the straw thoroughly free from the grain and conduct it to the rear of the machine. Here it is caught by



*Courtesy International Harvester Co.*

FIG. 42. — Skeleton view of the interior of a thresher.

the stacker and conducted away. The grain falls part through the grates below the cylinder and part between the slats of the racks, upon the vibrating grain board which slants toward the rear of the machine. Along this grain board it slides to the sieves, which hold back the coarser parts and let the grain and fine particles through. In being sifted, the grain passes through

a strong draft produced by a rotating fan situated below the grain board. This draft blows the chaffy material to the back part of the machine into the stacker. Some of the grains which have not been entirely freed of the glumes (chaff) will not pass through the sieve and are also too heavy to be blown into the stacker. To avoid losing these, a trough is provided which catches and discharges them into a tailings elevator by which they are carried to the front end of the machine and are sent through a second time. The grain, rid of impurities by sifting and fanning, is collected into a trough and discharged into an elevator. This elevator carries it to a weigher at the top of the machine which weighs and registers, then dumps it into wagons or bags. The stacker, which was mentioned as the device which carries the straw from the machine, may be a belt elevator. It is more usually, however, a "blower" or wind stacker, a tube through which the straw is blown by a strong current of air produced by a fan at the base. Where the blower is used, it can be so swung about from time to time that the straw can be built into fairly good stacks without manual labor on the straw stack. Where the belt elevator is used, two or more men are needed to take care of the straw. The larger machines now use the blower almost exclusively.

The sizes and capacities of threshers vary in

different sections of the country. Large fields make big machinery profitable. Where fields are small the machinery is also small. The width of the cylinder is always much less than that of the separator behind it. This is a necessary arrangement, for much space must be pro-

FIG. 43. — A typical four-stack setting ready to thresh.

vided if the straw is to be shaken thoroughly and thus rid of all its grain. Cylinders vary in width from 18 to 42 inches. The width of corresponding separators is 36 to 70 inches, respectively.

*The Power Thresher.* — In the early threshers, attempts were made to use water power as the motive force. This did not prove successful, chiefly because such machines could not be lo-

cated conveniently for the fields. Hence the necessity for a portable thresher became evident. Horse power soon came into use, and machines were built in such a way that they might be moved from field to field. Treadmill horse powers were used at first, but they soon gave way to the sweep powers which still are rather common in some regions. The sweep powers used in

FIG. 44. — Some farmers prefer to make rectangular stacks.

threshing are usually built for eight or ten horses, but both smaller and larger sizes are in use. The horses are hitched two abreast and one driver attempts to keep them all going at an even and uniform gait. Since the farmers furnish most of the horses used on the power, the driver seldom has a trained set to handle; and uniformly correct speed is therefore almost impossible. Another objection to this source of power is that since the threshing is largely done during the hot months

the horses soon become warm and tired. It is easily seen that horse power can not hold its place in competition with the steam engine.

The most generally used power for wheat threshing is now furnished by steam traction engines. These are built in sizes ranging from six to sixty horse power. They use straw, wood,

FIG. 45. — Pitching bundles into self-feeder on the threshing machine.

or coal as fuel, coal being by far most common. The advantages of the traction engine are: dependability for long hours of continuous operation; the readiness with which the proper rate of motion may be maintained; economy, — it being a cheaper source of power than horses; and its adaptability to quick change of location. Often it requires not more than five or ten min-

utes for a large steam threshing outfit to be pulled up and set in a new location.

Tractors which burn kerosene or gasoline have also come into general use in many places, especially where they are used for other farming activities. In some places the same gas tractor is used in plowing, seeding, cutting, threshing, and hauling

FIG. 46. — The steam traction engine. Power for operating threshers is furnished also by horses and by engines, but steam tractors are the most common.

the wheat to market. This, however, represents the extreme usage of the gas engine in the wheat-producing industry and is not typical in many countries. The horse is still the most generally used power in all but the threshing operation.

*The Rate of Work.* — With the smaller threshers, 500 bushels per day is considered a fair day's output. With moderate size machines 2000 bush-

els per day, and with the largest size 4000 bushels per day, are not unusual. These figures are for the outfits that make threshing a business during the season. In some districts there are individually owned machines with capacities of only 200 or 300 bushels per day, but they have not met with much favor in the wheat countries of the New World. In some European countries, especially France and Germany, the smaller outfits are widely used. They involve more hand labor than the larger threshers, inasmuch as they are not supplied with automatic band cutters, feeders, grain weighers, and elevators, or straw stackers. All this work must therefore be done by hand. Where labor is cheap and plentiful, this is not a serious objection; but where labor is high, and sometimes almost impossible to obtain at the season of the year when most needed, it gives to the automatic device a decided advantage.

FIG. 47. — The straw stack as built by the wind-stacker or blower. It is well named, the strawpile.

*The Time of Threshing.* — The time of threshing, like that of mode of harvesting, is directly related to prevalent rainfall conditions of the respective districts. In regions subject to frequent rains during the harvest season, only a small part of the wheat is threshed out of the shock, most of it being stacked as soon as dry enough and threshed at opportune times later in

FIG. 48. — A steam tractor threshing outfit pulling into a field.

the autumn. Sometimes it is not threshed until late in the winter. This method of threshing from the stack rather than from the shock is the one preferred because wheat can be stacked when it is too damp to be threshed. Another reason is that stack-cured wheat is not likely to suffer injury in storage, while wheat threshed out of shock must be very dry if it is to be safely kept. Wheat goes into sweat from 3 to 7 days after

stacking and usually does not become thoroughly dry again until about four weeks have passed. It is not advisable to thresh during this period as too much grain is lost in the straw. Grain threshed at this time is also not well fitted for bin storage. As soon as the wheat is out of the sweat, it is ready for threshing; it can, however, remain in the stack without injury until the winter is well advanced. The actual time of threshing will then depend largely on the conditions of weather, roads, and markets, as well as on the farmer's convenience and the community practice. A farmer rarely likes to be the only one in a community whose wheat is not threshed.

Where the harvest season is fairly free from rain and the wheat is bound, threshing out of shock is the general practice. In such regions, large machines are popular, for all are anxious to have the jobs finished as quickly as possible. Then threshing begins about a week after the wheat is cut and the end of the cutting period usually marks the beginning of the threshing season. That is the season of early rising. The shrill blast of the steam engine whistle at four o'clock in the morning wakens the farmer from his slumber, and shortly afterward the threshing is in full swing. At top speed the work usually continues, with but an hour's noon intermission, until after eight o'clock in the evening.

In some parts of California, Oregon, and Washington, combined harvesters and threshers are used. There the threshing season, though a busy one, is not marked by the almost feverish haste which is so evident where threshing is done out of shock.

*The Threshing Crew.* — The number of men in a crew varies widely. It depends on what the size of the machine is and whether the threshing is done from the shock or stack. In the latter case fewer men are necessary. With the outfits in common use from 9 to 30 men are employed. They are in three groups, the machine, the field, and the grain men. The first group includes a fireman-engineer, a coal and water boy, and a thresher tender. The field men are those who deliver the grain in the straw to the machine; from four to six are employed in stack threshing, from ten to twenty in shock threshing. The grain men are those who care for the threshed wheat and haul it to market or to the farm granaries.

The machine crew remains with the outfit, going with it from place to place. The field and grain crews are generally furnished by the farmer. In some places, however, the field crew is hired by the thresher owner and always accompanies the outfit. In such cases a complete threshing outfit includes the traction engine, fuel wagon, water

tank, thresher, cook shack, and dining tent. The men usually sleep in straw stacks or barn lofts.

Wages paid to the men are fairly good, ranging from one to four dollars per day and board. The field men usually receive $1.50 to $3.00 per day, the water boy receives less, and the engineer and thresher manager are generally paid larger amounts. Wages vary in different parts of the country and in different seasons, but in view of the fact that board and lodging are provided in addition, are always fairly good.

Where the farmer furnishes the field crew, exchange of help is the custom, neighbors assisting each other in turn. There first arrivals take the more preferable duties, and late comers draw the more disagreeable ones. Before the use of wind stackers the work in the straw pile was invariably the fate of the sleepy one, the dust and chaff making it a place to be avoided whenever possible.

When the noon whistle sounds the men all hurry to the farmer's home for dinner. They are dirty, sweaty, and grimy, and so the wash in the basins of cold water provided outside is refreshing although it is not always carefully done. A dinner of roast beef, fried chicken, salmon balls, potatoes and gravy, navy beans, green peas, beet pickles, bread and butter, honey, plum preserves, grape jelly, peach sauce, custard pie, cake,

and coffee is a model of quality and abundance. This has been prepared by the farmer's wife, with the assistance of two or three neighbors, and is usually placed at once on the table, which will accommodate about twelve people. Of course there is a scramble for places at the first table. The men are hungry after the forenoon's work. But there is plenty of food for all and those who eat at the second table have as great variety as those at the first. The men help themselves without formality, and the prosperity of the season as well as the health of the workers is reflected in the hearty appetites. It is a happy occasion, and the sallies of rural wit passed between the diners are met with uproarious laughter. The meal finished, there is but very little rest before the whistle calls the men for the afternoon's work, and by evening they are ready for as bounteous a supper.

FIG. 49. — The wheat farmer at threshing time.

*The Cost of Threshing Outfits.* — Threshing outfits are usually owned by individuals who do the work for as many of their neighbors as they can.

Competition keeps the number of outfits about right both for economy and efficiency. The cost of engines varies from $1000 to $2000 and for the threshers from $850 to $1175. Thus the cost for an ordinary sized outfit such as is widely used in the Central states is from $1850 to $3175. The selling price of the combined harvester-thresher is from $1725 to $4200.

FIG. 50. — The Combine. A combined harvester-thresher pulled by a gasoline traction engine.

The price charged for threshing wheat varies. Where the field crew is furnished by the farmer and the threshing is out of the stack, it ranges from four to five cents per bushel. Where the field crew is furnished by the thresher owner and the threshing is out of the shock, from eight to ten cents a bushel is the usual charge. Prices must of course be sufficient to pay wages for men and operating expense of machine. The latter

includes insurance, depreciation, and interest on investment.

### Questions and Exercises

1. What is meant by threshing wheat?
2. Explain the use of the flail.
3. In what ways is the threshing floor an improvement over the flail?
4. By making inquiry of farmers and implement dealers, learn what makes and sizes of threshers are used in your locality. If possible study a threshing machine and try to learn the names and uses of its essential parts. It is interesting to tell the story of what happens to wheat inside of a thresher in operation.
5. What advantages have steam engines over horses as power for threshing?
6. What is the busiest threshing month in your vicinity?
7. How many men usually make up a threshing crew?
8. About how many bushels is considered a good day's work in threshing?
9. Suggest reasons why exchange of labor among farmers is often preferred to hired help.

## CHAPTER VI

## *LOCAL TRANSPORTATION AND STORAGE*

**Field Haulage before Threshing.** — The first haulage of wheat occurs in the field. The unthreshed wheat must be brought either to the stacks or to the thresher. In some cases the threshing, whether from stack or shock, is done in the farm lot. This is a convenient arrangement, for in most cases the straw can be delivered directly into barns or sheds where it is to be used. It also has an advantage over field threshing in that it delivers the grain nearer the home storage bins or wagon roads. The disadvantage of this system is that

FIG. 51. — Wheat bundles are bulky to haul.

the unthreshed wheat is bulky to haul long distances. This plan is therefore generally followed only where the regions are made up of small

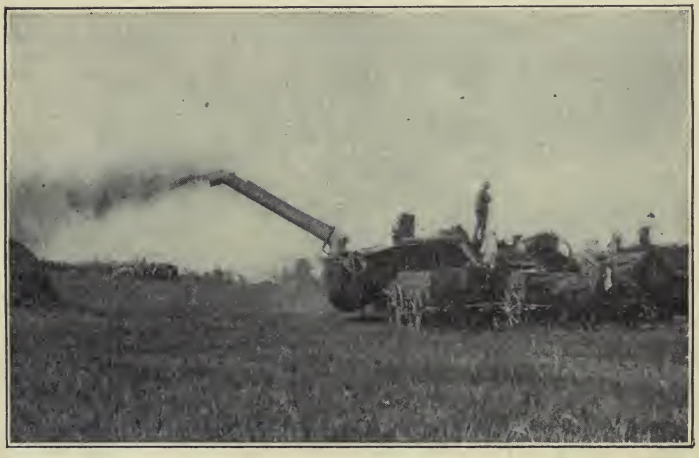


FIG. 52. — The wagons are arranged side by side at the thresher to receive the grain.

fields or where the straw is to be used either as rough feed or bedding for cattle.

Where farms are large, the threshing is performed in the field. If threshing is done out of shock, different settings are made in order to lessen the haulage of the unthreshed wheat; if out of stack, the stacks have been grouped in different parts of the field for the same reason. The distances vary from a few rods to a mile or more, but generally field haulage of unthreshed wheat does not average much more than a quarter of a mile.

**Field Haulage after Threshing.** — *Loose Wheat.* — The grain is hauled from the field in farm wagons, by many called lumber wagons. They are filled by the thresher-elevator, which weighs the wheat, usually in half bushel lots, registers amount, and dumps it into the wagons. The driver levels the grain in the wagon box until it is about evenly filled. While the elevator is delivering to one wagon another is driven alongside, and when the first is filled the delivery spout is moved to the second. The first load is then hauled away and another wagon takes its place. Usually the grain can be delivered at either side of the thresher, so the side most nearly free from dust is, of course, the one used.

The capacity of the wagon is from 50 to 70 bushels where two-horse teams are used for pulling the loads. This amount naturally varies with the conditions of the roads in different sections and seasons. In very hilly or very sandy regions from 25 to 30 bushels make a full load. If greater quantities are carried, more power is applied, and four horses are often used instead of two. In some of the fields of the smooth plains regions of Montana, North Dakota, and Canada, larger wagons holding 150 bushels and drawn by four or six horses are commonly found.

The lumber wagon, with capacity of 50 or 60 bushels, previously mentioned, is, however, the

most generally used for haulage from field to granary or to the local market. When roads are good a man may often be seen driving one such wagon fully loaded, and leading a team pulling another one.

FIG. 53. — The grain is leveled in the wagon until the box is about evenly filled.

*Sacked Wheat.* — In the small farm sections of eastern United States and in the large fields of the northwest, especially California, Oregon, and Washington, wheat is often sacked at the thresher. That plan is not, however, generally followed in the Central states or in the High Plains region.

Sacking wheat puts it into convenient form for handling and involves very little waste. It has been found practical in the Eastern states because quantities are small and there is considerable

local shipment in less than carload lots. Also where grain-tight bins cannot readily be provided, the sacked wheat presents less difficulty in storage and handling than does the loose grain.

In the Northwest, the sacked wheat is in favor because of the export trade. This trade, though important, has not caused the establishment of great terminal facilities which are equipped for handling loose grain. Such facilities have been provided for Eastern markets.

*Local Storage.* — After the wheat is threshed it may either be sold at once or held for a time by the producer in what is known as local or farm storage. Thus the time of disposal of the wheat is closely related to the stage of development of a country, to the quantities produced, and to the relative importance of the wheat crop compared with other farm products. The great wheat districts of the High Plains, of the Pacific Northwest, and of Canada are regions of recent development. The land is still new, crops are large, but facilities for handling them are meager. Other possible sources of income not having been developed to any great extent, wheat is by far the most important crop. These combined factors cause the wheat to be marketed as soon as threshed and there is relatively but little local storage. The farmer sells his wheat because he has a large

surplus and no place to keep it, and because he needs the money. During the rush of some marketing seasons in Canada the only means of storage has been the placing of wheat in great piles along the railroad tracks in small towns. This unintentional and ruinous form of storage was due to inability to obtain sufficient cars for prompt shipment. Increase in amount of wheat grown has been so rapid in some of the recently developed parts of Montana and Canada that the railroads have found it a serious task to move the crops. As conditions are becoming better understood this problem is being solved.

FIG. 54. — The wheat is hauled from the field in farm wagons. This load was fifty-eight bushels.

*Storage in Sacks.* — Local storage in sacks for brief periods is customary in parts of California, Oregon, and Washington. Great quantities are often piled out of doors awaiting shipment. Sometimes board covers are laid on the pile, though often no cover is provided. Such arrangements are possible in this country because of the almost

complete absence of rains during the late summer season. Wheat stored in such manner must necessarily be disposed of before the rains of autumn begin, so the period of storage is brief. If the owner expects to hold his crop for a longer time, he places it in a warehouse. There are few warehouses, however, because the practice is that of selling immediately after harvest.

The conditions just described are in rather marked contrast to those in the smaller wheat farm districts of Eastern states. There, local storage both in bins and sacks is quite common. This is due to the fact that the quantities grown by each farmer are not large, and that he has other crops which also help to furnish his income. Marketing here is quite generally done with local mills and bears a close relation to their demands. These conditions tend to discourage early selling. Other reasons why farmers favor holding wheat are because it can be readily converted into cash at any time, and because frequently the rise in price, a few months after harvest, yields an increased return to the producer. Where farmers have other sources of income many defer selling because of such possible increase.

*Storage in Granaries.* — In the Central states local storage is very important. This is particularly true in the older, more densely settled portions where good farm buildings prevail. There

granaries are considered essential parts of the farming equipment. On moderate sized farms, buildings of from 2000 to 5000 bushels storage capacity are common, and some farmers have built granaries holding as much as 10,000 bushels. These are used mainly for wheat since corn is stored in the ear in cribs. Sheet steel granaries or bins are in favor in many parts of the country and especially so in this section. These bins are cylindrical, the diameters varying from 6 to 18 feet, height from 6 to 12 feet, and capacity from 135 to 2500 bushels. Their advantage is due to their low cost, safety from fire, freedom from rats and mice, and their moisture-proof qualities. The principal motive for farm storage in this section is to take advantage of the rise in prices expected after the main rush of marketing in the Northern and Western districts has passed. Sometimes the rise does not occur or is not high enough to satisfy the

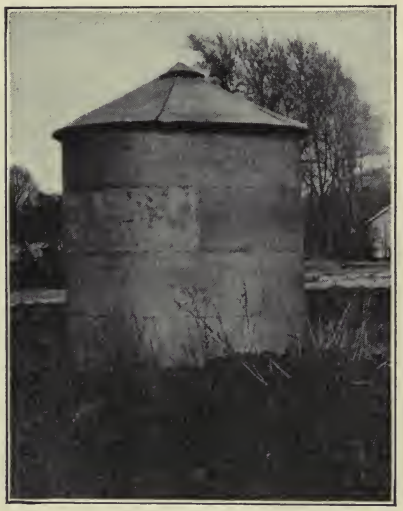


FIG. 55. — A sheet steel granary.

producers. Then the wheat may be held until the following year, and sometimes, though not often, for two or three years.

**The Methods of Unloading.** — The grain is unloaded into storage by shoveling into the bins of the granary. This is hard work, but more

FIG. 56. — A typical farm granary. The elevator is also shown with wagon in position for unloading.

labor is necessary later when the wheat in order to be marketed must be reloaded by shoveling back into the wagons. On the better equipped farms, elevators are provided. In this case the grain can be unloaded by raising the front end of the wagon, opening the back end gate, and allowing the wheat to slide into a hopper from which a

belt conveyer carries it to the top of a bin and discharges it. The team used in pulling the load from the field is hitched to a small horse power and thus serves to operate the unloading machinery.

A few farmers have built granaries arranged with overhead driveways so that the load can be driven directly over the bin and there dumped. Such equipment adds so much to the cost that it is not ordinarily considered profitable.

In general, manual labor prevails for unloading into farm granaries. Power plants and elevated driveways are, in most cases, considered too expensive to be profitable. But there is a strong tendency at this time toward the use of mechanical unloaders in the Central states.

**Good Roads in Relation to Farm Storage.** — A matter of vital relation to farm storage is the condition of the roads to the local market. If the roads are good at threshing time, many farmers will sell at once rather than store at home and take chances on finding roads in bad shape when later they wish to sell. On the other hand, when roads are poor at threshing time, home storage is thereby encouraged. This is an especially marked control, since a large part of the wheat-producing section of our country is almost entirely without macadamized roadways; and, in much of this region, but little attention has been given to

maintaining even good earth roads. The farmers have recently begun to take positive steps toward road betterment because they now realize that good roads reduce the cost of marketing. The importance of good country roads in wheat districts is clear when we know that it is necessary for farmers to haul as far as eight to ten or even twenty miles to a shipping point.

**Storage in Town Elevators.** — At the shipping stations, grain-handling buildings called elevators have generally been built at the side of the railroad tracks. These have several bins with a combined storage capacity of from 5000 to 20,000 bushels. The elevator is a tall building from 45 to 70 feet high, bearing some resemblance to a tower. It is usually painted red. In the smaller places the elevators are ordinarily the most prominent buildings in town. The farmer first hauls his load upon the scales, which are either separate from the main building or are connected with it. The load is weighed, wagon and all, then driven upon a platform in the elevator where it is unloaded by dumping. This consists of opening a trap door in the platform, taking out the rear end gate of the wagon and tilting the platform, which swings on an axis, so that the grain slides into a bin below. When the wagon is empty it is again weighed, and in this manner the net amount of grain is determined. Driving the wagon out of

the elevator causes the platform to resume its horizontal position and become locked, leaving it ready for the next load. The grain in the lower bin is then removed by means of endless bucket elevators to upper bins or into railroad cars near by. In this way a large quantity of grain can be cared for in a very short time and with very little labor.

Because of the uncertainty in the condition of the roads at a time when the farmer may wish to sell, he sometimes arranges to haul his grain directly from thresher to elevator and store it there rather than to make immediate sale. In such case he pays storage on his wheat and, of course, depends on increased price to reimburse him for the amount of storage paid, as well as to pay interest on the money tied up in the wheat. There is an apparent advantage in this arrangement since the wheat is weighed at time of delivery and the owner avoids the loss due to shrinkage. When it is stored on the farm the owner must stand this loss directly. Storage charges usually take this into consideration, however, so that the gain is more apparent than real.

Local elevators usually have a very limited capacity for storage. The desirability of accommodating all customers has led to a practice sometimes resorted to of shipping the wheat to storehouses in large centers. Thus, it has been

found that some small town elevators would show by their records that they had in storage four or five times their capacity, while an investigation would disclose the fact that most of the bins were empty. The farmers held certificates stating that they had stored a certain number of bushels. They could sell at any time, a possibility which then meant that they could exchange their wheat certificates for cash on demand based on current wheat prices. This has been called wheat banking. It shows how country roads, wheat crops, and farm and elevator storage are intimately linked with business operations and reach into numerous channels of trade.

### Questions and Exercises

1. Why are wheat stacks in most cases built in the field rather than in the farmyard?
2. Describe loading the wheat at the thresher.
3. What are the advantages of handling the wheat in bulk instead of in sacks?
4. Suggest conditions which make it preferable to sack the wheat.
5. Under what conditions are farmers most likely to sell their wheat as soon as threshed?
6. Why are granaries usually not numerous in newly settled wheat regions?
7. What are some advantages of sheet steel granaries?
8. How do the conditions of the roads affect farm storage of wheat?

9. Suggest some advantages of storage in town elevators; some disadvantages.

10. What are the factors that the farmer must take into consideration when he is contemplating placing his wheat in storage?

FIG. 57. — Principal wheat regions of the world.

# CHAPTER VII

## *FACTORS IN WHEAT PRODUCTION*

THERE are three important factors to be considered in the actual production of wheat: the land, located where soil and climatic conditions are favorable; the machinery for tillage and harvesting; and the power for driving the machinery. Since these factors vary greatly in the different wheat-growing regions, the production, both in the items of cost and quantity, is directly concerned with each of them.

**Wheat-producing Areas.** — The principal wheat-producing countries are in the temperate zones. They lie between parallels 30° and 60° north and 27° and 40° south latitudes. The exceptions to this are the three plateau-like areas including parts of India, Egypt, and Mexico. In these plateaus the higher altitude offsets the effect of tropical location.

*The Effect of Climate on Wheat Production.* — Though wheat may be grown in warm latitudes, it is of commercial importance only in countries which have warm summers and moderately cold

winters. The effect of temperature is clearly shown. Wherever wheat is produced on a large scale, it makes its early growth during the cool and moist season of the year and has a warm and relatively dry season for ripening.

Wheat requires only a moderate rainfall during its growing period, a great deal less than some of the other cereals. Thirty inches per year, properly distributed, is ample for any of the commercial varieties. Some of the drought-resisting wheats, such as Durum Wheat or Club Wheat, are successfully produced where the annual rainfall is even less than 15 inches. Commercial production is most important in temperate regions of moderate rainfall, and of relatively dry harvest seasons.

The form in which the moisture is likely to come, together with winter temperature conditions, determines whether winter or spring wheat will predominate in a given section. If winter temperatures rarely drop to more than 20° below zero, winter wheat is grown regardless of the amount of prevalent snowfall, because such a degree of cold does not prove injurious to the hardier varieties. Where the temperature during the winter season falls much below the point mentioned, unless a snow cover can be depended upon to protect the ground, spring wheat is grown. Thus because of the cold winters and light snowfall, spring wheat is raised in North

Dakota. Here the winds in sweeping over the open plains country blow the snow into drifts, and the fields, deprived of the protecting snow mantle, are exposed to the extreme cold. The value of the snow cover is shown by the fact that winter wheat is grown in some parts of north-

FIG. 58. — A snow cover on the ground serves to protect winter wheat.

central Wisconsin, a region of heavy snowfall, while in the southeastern part of the state, with a milder winter temperature but a lighter snowfall, spring wheat is raised.

Where the normal rainfall is insufficient to make wheat crops reasonably certain, irrigation is practiced. This is available only for restricted areas because of water supply or of unfavorable

location or topography. Though irrigation adds materially to the cost of production, it reimburses the outlay by giving much greater returns per acre. On the whole the amount of wheat raised under irrigation is small. Yet in many valleys in the Western states it is an important industry. The greater part, however, of the wheat of commerce is grown under natural rainfall conditions.

*The Soil and Wheat Production.*—Wheat thrives well on a number of soils of widely different characteristics, ranging from those of heavy clay to those of light sandy content. Its adaptability to different climatic and soil conditions makes possible its extensive cultivation. In the United States the soils of the principal wheat-growing area are of four general classes. These are glacial drift, loess, high plains soils, and valley bottom soils. Generally they are all rich in the elements needed as food by the wheat plant, and contain them in available form. Where winter wheat is grown, silt loam soils are favored, as they are somewhat less liable to heaving than the more friable sandy loams. Heaving of the soil is caused by successive freezing and thawing. This often partially uproots the wheat and causes it to be winterkilled.

Ordinarily soils that are adapted to wheat are also suited to corn and other cereals. Climate and prices are the chief controls which determine

the choice of wheat, corn, oats, rye, flax, and barley.

*Enemies and Diseases that affect Wheat Production.* — Related to both soil and climate, and seriously affecting the production of wheat, are its enemies and diseases. Like all living things, wheat must struggle to live. It is hindered by weeds, plant diseases, and insects.

*From Riley, 7th Missouri Report.*

FIG. 59. — The chinch bug: adult. *a*, *b*, eggs; *c*, newly hatched larva with enlarged tarsus at *d*; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, *i*, *j*, leg, tarsus, and beak of adult bug.

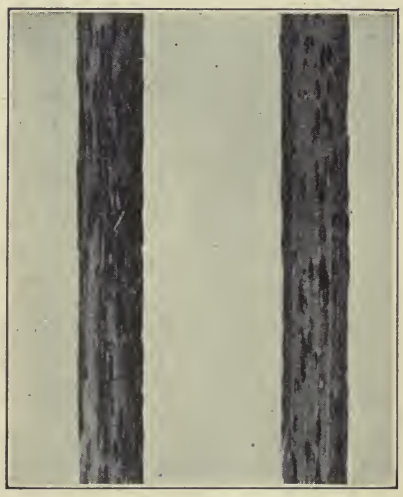
*Weeds.* — Weeds interfere with the growth of wheat by choking it out, thus lessening the yield, and reducing the quality of the grain. Of the many weeds that attack wheat fields the most persistent are those commonly known as Chess, Russian Thistle, and Wild Mustard. In these the seeding methods are so well perfected that their extermination is difficult. The general methods employed in combating weeds and thus prevent-

FIG. 60. — The Hessian fly: adult female at the left, adult male at the right — both enlarged several times.

*Rearranged by M. H. Swenk, from Webster, Marlatt, and Washburn.*

FIG. 61. — The later stages of the Hessian fly: *a*, four larvæ changing to the flaxseed stage, enlarged four times; *b*, flaxseed or puparium, much enlarged; *c*, larva taken from flaxseed, much enlarged; *e*, infested wheat plant showing emergence of pupæ and adults, enlarged.

ing crop destruction are applicable in the case of wheat. The best rules are, — first, see that the wheat seed is clean; second, provide a carefully prepared seed bed; third, keep the weeds killed which tend to grow on vacant ground in and about the fields. This latter precaution also assists in holding in check the insect enemies, — the chinch bug and Hessian fly. These pests, since they also feed upon weeds and grasses, are sure to find harboring places here.



*From Plant Diseases — Freeman.*

FIG. 62. — Rust on wheat stems. Note the spots which indicate the growth of this fungus which lessens the vitality of the plant.

*Smut and Rust.* — Fungus diseases are more difficult to combat. In the first place they usually have a firm hold upon the wheat plant before they are discovered and, second, they are not so well understood. The most common of these enemies are known as smut and rust. These are tiny parasitic plants which develop within the wheat plant. During the process of reproduction, however, parts of these plants worm their way to the

air and the spores appear on the outside. Rust spores then appear upon the leaves. Smut spores, which appear about the time when the wheat is in flower, cover the spike. Spores have the same relation to parasitic plants that seeds have to higher plants; and, since they are innumerable, these diseases spread rapidly. Smut spores attack the grain in different ways. Sometimes they fill the grain, making what are called smut balls. Sometimes only the stem of the plant is affected. This weakens the plant and consequently the grain yield is small. Rust living within the plant does its damage by using the food materials which are necessary for the growth of the host. In this way the wheat plant is weakened and a low yield and shriveled grain is sure to result.

*From Plant Diseases — Freeman.*

FIG. 63. — Stinking smut of wheat: *1*, an infected spike; *2*, smut infected spikelet; *3*, smutted kernels.

There is no known remedy for wheat rust. Preventive measures, however, are quite effective. Much the same methods are employed as are used in combating weeds. The seed wheat should be clean and should be selected from grain that has been free from rust. All weeds and grasses that aid the growth of the rust should be destroyed. Smut, likewise, is destroyed by treating the seed with preparations which kill the smut spores without injury to the grain. A crop which is thoroughly infested with smut cannot be saved. This makes vigorous preventive measures necessary when the seed wheat is even suspected of infection.

*The Size of Farms which produce Wheat.*—Wheat is a product of the small farm as well as of the large. In Italy and Greece, five acres is a fair-sized field. In Sweden, ten to twenty acre fields are common, while in the Western plains region of the United States there are many fields of from 300 to 2000 acres. The size of the farm depends upon density of population and upon isolation of the country. Fields in Belgium and the Netherlands, because of a very crowded population, are small. In certain remote parts of Asia Minor, the fields are likewise small from the very fact of their isolation. Here lack of transportation facilities compels the people to raise their own wheat and grind their own flour. Furthermore, their

implements are crude and each man is able to produce only a small quantity. Under these conditions he would find a large field useless. A marked contrast is this condition with that of Kansas, the Dakotas, or Canada. There, railroad transportation is well developed, modern implements are used, each man is able to produce abundantly, and large farms are the rule. The great bulk of the wheat of commerce comes from countries in which regions of large farms abound. These are found in Russia, Argentina, Australia, Canada, and the United States. In these countries the per capita production is high and the local population does not use all the wheat produced. A surplus, therefore, available for export purposes is the result. Wheat is likewise a favorite crop in newly settled regions because it gives large yields and quick returns. In new regions the price per bushel is lower than near the great markets, but the low price of the land more than offsets this disadvantage.

The average area of wheat on the farms in the United States is reported by the Thirteenth Census as being 30.3 acres. That different sections vary greatly from this average is shown by the fact that the average wheat acreage per farm in Massachusetts is 1.3; in New York, 8.4; in Nebraska, 41.4; in North Dakota, 137.9; and in Washington, 152.8 acres.

*The Farm Machinery.* — The implement equipment for wheat production varies with the size of the farm. The machinery used where fields average less than 15 acres is simple. Much hand labor is usually involved. Where walking plows, small harrows, and seeders are used, the cost per acre for implements is nearly as high as in places where larger farm units prevail. Without giving much attention to the equipment used on either extremely large or extremely small wheat farms, it is of interest to know the implements needed for typical conditions. Let us take as the basis the average wheat acreage per farm in 1909. This was reported by the census to be 30.3 acres. A fair equipment for raising wheat on such a farm would be:

| | |
|---|---|
| Three horses, $150 value each | $450.00 |
| One plow | 40.00 |
| One harrow | 25.00 |
| One drill | 50.00 |
| One binder (six-foot cut) | 125.00 |
| One rack for hauling bundles | 20.00 |
| One wagon for hauling grain | 60.00 |
| Total | $770.00 |

Where such farms prevail the threshing is hired done, so no investment is needed for that part of the work. Much of this machinery would be used for other farm purposes as well as for wheat, and therefore the cost should not be considered as for

wheat alone. In fact fields of 30-acre size are only common in the corn belt states, and there other small grains and corn are also extensively grown.

The equipment needed in the regions where wheat is the principal crop is more extensive. Fields there are usually 100 acres or larger. For such conditions, the wheat-raising outfit consists essentially of the following:

| | |
|---|---|
| Six horses, $150 each | $900.00 |
| One gang plow | 64.00 |
| One harrow (24 feet) | 24.00 |
| One disc | 40.00 |
| One drill | 105.00 |
| One binder (eight-foot cut) | 150.00 |
| Two racks for hauling bundles, $50 each | 100.00 |
| Two wagons for hauling grain, $85 each | 170.00 |
| One elevator for unloading and loading grain | 175.00 |
| Total | $1728.00 |

For larger fields the equipment is increased in proportion. Thus the cost per acre of necessary equipment is not materially reduced.

Threshing outfits are usually owned by a farmer; only a few machines, however, are owned in each community. These few can easily take care of the work because the working capacity of a threshing machine is so much greater than that of the other machinery involved in wheat growing. The cost of the machine is likewise relatively high.

To hire the threshing done is the economical plan. It is prevalent in all sections except on the "bonanza farms," found in some parts of North Dakota, California, Washington, and Canada. For wheat farms of 500 acres or more, the grower generally provides his own thresher.

FIG. 64. — A binder left standing in the field for many weeks after the harvest is done. A poor practice.

**The Power used in Wheat Raising.** — Horses constitute the chief power used in the world's production of wheat. However, in the more progressive countries, and particularly in sections where large fields predominate, much of the work which was formerly done only by horses, is now done by steam and gas engines. Tractors are used for plowing, seeding, harvesting, threshing, and even marketing. The cost of this method is usually not much less per acre than that of horse labor, but the daily capacity is much greater. Since wheat needs prompt attention, this is the great point in its favor. But even in such

regions a great deal of the work is done by horses.

In contrast to the conditions described there may be mentioned some of the countries such as Palestine, Asia Minor, and Egypt, where other animals are used. Here cattle are quite generally made use of to pull the plows. In Egypt a team made up of a cow and a camel is so common that the sight arouses no comment. Here, likewise, for seeding and harvesting hand labor prevails. In the Mediterranean countries, manual labor is cheap and therefore plays a much more prominent part in wheat production than it does in the United States or Canada.

We may consider, then, that the power employed in the world's wheat production varies from the cow and camel method to that of mighty machinery, great engines, and practically no hand labor. These are real and interesting extremes. But after all the bulk of the world's wheat is produced by men who use up-to-date machinery of moderate size with horses as the pulling force.

*The Importance of Machinery.* — Few of us realize the tremendous saving in time and expense that we enjoy because of modern machinery. It is estimated that as recently as 1830 the average amount of human labor required to produce a bushel of wheat in the United States was about 3 hours and 3 minutes. In 1899 it required but

10 minutes.[1] This difference is due largely to the increased use of machinery. In 1830 the plow was a clumsy wooden affair, the seed was sown by hand and was harrowed into the ground by drawing brush over it. Furthermore the grain was cut by cradles and hauled to the barn, where it was threshed some time during the winter by beating it with flails, and separated by hand fanning mills. Now the ground is turned by steel plows and pulverized by discs, the seed is sown mechanically, and the grain is cut and threshed by steam-driven machines of great capacity. All this change has come in less than a century.

**The Yield of Wheat.** — The United States and Russia are the greatest wheat-growing countries in the world. The United States in 1914 produced 891,017,000 bushels of wheat, and Russia in 1913 produced 962,587,000 bushels. In both of these countries wheat farming is carried on extensively and large fields are common. But the yield per acre is much less in these countries than is the average in some other regions. Note for example the average yield per acre in the following countries for the years 1901-1911 inclusive:

| | |
|---|---|
| United Kingdom . . . . . | 32.8 bushels |
| Germany . . . . . | 30.7 " |
| France . . . . . | 20.1 " |

[1] Twelfth Census Report, Vol. X, p. 352.

| | |
|---|---|
| Austria-Hungary | 19.9 bushels |
| United States | 14.3 " |
| Russia | 10.0 " |

The reasons for the relatively low yields reported by the United States and Russia are, — (1) extensive rather than intensive cultivation, (2) continuous wheat cropping, (3) small amount of fertilizers used, and (4) large acreage grown where climatic conditions are not favorable for heavy yields. The last reason is often overlooked. Its importance, however, cannot be questioned. Regions of somewhat scanty rainfall may produce only moderate yields yet be more profitably devoted to wheat than to other crops. Population in such places is scattered, fields large, and land low-priced.

The differences in yield per acre in the wheat countries of the world are very similar to those of different sections of the United States. Kansas and North Dakota are the two states leading in total production, but they are far down the scale in yield per acre. In 1913, a year of very high wheat production, the yield per acre in Kansas averaged only 13 bushels, in North Dakota 10.5 bushels, while Maine reported an average of 25.5 bushels per acre. Yet no one would question that wheat is a very profitable crop in the first named states. Although low yields may be profitable in some places, higher yields are desirable and so there

is need for studying methods of increasing the yield.

*The Effect of Tillage.* — Careful preparation of seed bed is essential. Extensive farming often involves working a part of the ground when conditions are unfavorable. Because of the size of the field, only part of the plowing is done at the right time, — part of it must be delayed. When the remaining part is plowed, sometimes the soil is too dry, at other times it is too wet. Large acreage is depended upon to make up for the lessened yield per acre, caused by such conditions. With a denser population and the consequently increased competition, greater care in planting and preparation becomes necessary.

*The Importance of Seed Selection.* — Conditions in the wheat-growing regions of North America are so diverse and settlement in many parts so recent, that the varieties best suited to different localities are still in doubt. Constant experimentation is in progress that lines of improvement may be found for these cases. With more complete adaption of variety to local soil and climate conditions, higher yields will follow.

*The Rotation of Crops.* — Wheat farmers are coming to realize that continuously planting to the same crop on the same soil soon causes decreased yields. This is due to the fact that the amount of available food material necessary to the particular

plant is diminished and crop rotation or summer fallowing prolongs the period of high productivity by maintaining a favorable physical condition of the soil.

*The Use of Fertilizers.* — The soil must possess in available form the essentials for plant growth, viz., (1) sufficient though not excessive moisture, (2) lime, and (3) the indispensable elements of plant food, nitrogen, phosphoric acid, and potash. The last three are usually contained in barnyard manure, which is considered an excellent fertilizer. The old sections of the United States, as well as most European countries, have ample rainfall, but long-continued cropping has reduced the supply of available plant food in the soil. In order to raise paying wheat crops the deficiency must be overcome. This may be done by applying prepared mixtures which are high in the particular plant foods needed. Such mixtures are known as commercial fertilizers. The cost of this fertilization is heavy, but the returns are so materially increased that the farmer is much more than repaid for his outlay.

In the more newly settled regions commercial fertilizers have not proved profitable. The soils are naturally very fertile and cropping has not continued long enough to deplete the available plant food. This condition is generally true of the states west of the Mississippi River. Here to most of the

farmers the term *commercial fertilizer* is practically unknown. Such is not the case, however, in the Eastern states. There fertilizers present an important item of cost in wheat production. The following table shows some marked contrasts in the cost per acre in selected states.[1]

*Commercial Fertilizers in Wheat Production, 1909*

| State | Cost per Acre | State | Cost per Acre |
|---|---|---|---|
| Maine . . . . | $5.00 | Nebraska . . . | $ .09 |
| Pennsylvania . . | 2.83 | Kansas . . . . | .06 |
| New York . . . | 2.50 | North Dakota . | .06 |
| Ohio . . . . . | 1.76 | Oklahoma . . . | .03 |
| Minnesota . . . | .18 | | |

It is readily seen that the states which can produce profitable crops without the use of commercial fertilizers have a distinct advantage in cost of production. In such regions care should be taken to postpone as long as possible the time when the use of such fertilizers will become necessary. Careful tillage, scientific crop rotation, and the use of barnyard manure should be practiced.

*The Effect of Irrigation on Wheat Production.* — Where the supply of moisture is deficient, irrigation is necessary. This is the case in many of the valleys of the western mountain states. Al-

[1] Crop Reporter, May, 1911.

*Cost of Wheat Production*[1]

| State | Commercial Fertilizer | Preparation | Seed | Planting | Harvesting | Threshing | Wear and Tear | Land Rent | Total Cost | | Yield, Bushels | Cost per Bu. | | Farm Value per Bu. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Without Rent | With Rent | | Without Rent | With Rent | |
| Me. | $5.00 | $3.50 | $3.50 | $.43 | $2.00 | $1.13 | $1.12 | $7.00 | $16.68 | $23.68 | 25.0 | $.67 | $.95 | $1.12 |
| N. Y. | 2.50 | 4.23 | 2.20 | .61 | 1.95 | 1.94 | .66 | 3.91 | 14.09 | 18.00 | 23.4 | .60 | .77 | 1.05 |
| Va. | 2.54 | 2.50 | 1.55 | .53 | 1.24 | 1.18 | .41 | 2.74 | 9.95 | 12.69 | 15.0 | .66 | .85 | 1.05 |
| O. | 1.76 | 2.86 | 1.75 | .48 | 1.40 | 1.49 | .41 | 4.22 | 10.15 | 14.37 | 18.3 | .55 | .79 | .99 |
| Ill. | .27 | 2.01 | 1.50 | .35 | 1.19 | 1.46 | .43 | 5.33 | 7.21 | 12.54 | 19.5 | .37 | .64 | .97 |
| Neb. | .09 | 1.48 | 1.28 | .44 | 1.22 | 1.38 | .49 | 3.70 | 6.38 | 10.08 | 18.3 | .35 | .55 | .88 |
| N. D. | .06 | 1.95 | 1.31 | .44 | 1.03 | 1.60 | .38 | 2.22 | 6.77 | 8.99 | 14.4 | .47 | .62 | .96 |
| Wash. | .38 | 2.36 | 1.24 | .49 | 1.72 | 1.94 | .54 | 4.43 | 8.67 | 13.10 | 25.0 | .35 | .52 | .90 |

[1] Crop Reporter, May, 1911. Data for 1909.

though the cost of production is greatly increased, the yield is not only large but certain, thus making satisfactory returns possible. This method involves very intensive farming and a much greater amount of manual labor. For this reason acreages are not high. Under such conditions other crops are often more profitable and wheat is crowded out. In many such districts it has given way to fruit and alfalfa.

**The Cost of Production.** — The cost of producing a bushel of wheat differs greatly in the various states. The table on p. 118, made up of states chosen as typical of the different sections, clearly illustrates this fact.

The data in the foregoing table are of interest chiefly to show the importance of several factors, — (1) where fertilizers are used the yield is relatively high and thus compensates for the extra cost; (2) farm values per bushel are highest near the Eastern markets; (3) land rentals are lowest where yields are low, thus offsetting, in part, the disadvantage; (4) land rental is everywhere an important factor in the cost per bushel of wheat production.

Special investigations were carried on by the Nebraska Experiment Station in 1909 and 1910 for the purpose of determining, as accurately as possible, the cost of producing wheat in that state. The results are given in the following detailed form:

*Cost of Wheat Production in Nebraska*

| Year | 1909 | 1910 | Average |
|---|---|---|---|
| Number of replies | 139 | 150 | 289 |
| Interest and taxes (or rent) | $4.463 | $5.098 | $4.780 |
| Plowing | 1.273 | 1.272 | 1.272 |
| Harrowing | .286 | .279 | .282 |
| Discing | .443 | .404 | .423 |
| Seed | 1.461 | 1.342 | 1.401 |
| Seeding | .453 | .388 | .421 |
| Harvesting | 2.456 | 2.110 | 2.283 |
| Interest and depreciation on machinery | .505 | .685 | .595 |
| Miscellaneous | .727 | .734 | .731 |
| Total cost per acre | $12.067 | $12.313 | $12.188 |
| Yield per acre | 22.9 bu. | 21.6 bu. | 22.2 bu. |
| Cost per bushel | 52.7 cents | 57 cents | 54.9 cents |

Nebraska Experiment Station,
Bulletin No. 122.

## Questions and Exercises

1. What are the three great factors to be considered in wheat production?

2. What climatic conditions are most favorable to wheat production?

3. Where is irrigation important? What are its advantages and disadvantages? Suggest reasons why, in the United States, other crops are grown more extensively under irrigation than is wheat.

4. What are weeds? How are they injurious to wheat?

5. How do rusts and smuts injure the grain? How

may these pests be controlled? Infer the significance of the term *rust*.

6. In general what is true of the size of farms where commercial wheat is produced?

7. What relation exists between density of population, size of farms, and export of wheat?

8. About what is the average size of farms in your locality or state?

9. What machinery is used in wheat production in your home region? Find cost of equipment and compare with that given in the text.

10. Account for the fact that wheat may be a profitable crop in regions where the yield is very low.

11. By what methods may the wheat yield in a given locality be increased?

12. What are some of the advantages and disadvantages of extensive wheat farming?

13. By inquiry find the approximate cost of wheat production in your locality and compare with that given in the published tables.

# CHAPTER VIII

## *MARKETING*

**The Methods of Marketing Wheat.** — Methods of disposing of the wheat crop differ in the various countries. The exchange of wheat for flour at small country mills is the custom in many of the smaller European nations and even to some extent in the United States, although rarely is this done in the greater wheat-producing districts. The exchange or trading of wheat for other products has generally given way to selling; and the selling scheme, *i.e.*, marketing, varies from an operation which is very simple to one which is very complex.

*Wheat sold to Local Mill.* — The simplest method of marketing wheat is that of selling to the local mills. Flour mills are quite generally found throughout the older settled wheat districts, yet in most cases they do not buy directly from the farmers. Direct selling, that is, selling from producer to mill, is prevalent now in this country only where fields are small and where the total production in a community does not greatly exceed the consumption. In such a region of small

fields where numerous small water powers are found, the building of many mills of low capacity serves to favor direct marketing. Such conditions exist in some of the Eastern states, particularly in the Piedmont and Appalachian provinces. In these localities there are many swift streams and good dam sites which render cheap power available for operating the mills. The country, which was settled early, supports a fairly dense population and farms are not, as a rule, very large. Selling directly to the mill is not only the simplest method but under these conditions is the most economical. But wheat thus sold does not enter largely into commerce. The local mill manufactures it into flour which goes back directly to the people of the community. Since circulation is chiefly local, little or no railroad transportation is necessary.

*Shipment to Large Mills or Markets.* — Let us look at a contrast to the conditions just described. The great wheat areas of the Central and Western states and of Canada are very different from those of Virginia and Pennsylvania. Here a large surplus of wheat is grown each year for which distant markets must be sought. In the newer portions there are few mills, and even in the older sections the supply of wheat far exceeds the local demand. This has caused the development of large milling centers and of markets so located that they are

convenient for export purposes or that they may supply the trade of Eastern sections. The farmer can sell to these distant markets either directly or through marketing agencies which have sprung up, usually in the form of elevator companies. Let us consider the processes involved in each of these two plans.

*Direct Marketing.* — Farmers who live but a short distance from town are inclined to haul directly from the thresher, since only a small force of men is necessary to handle the grain thus. From farms which are 6 to 10 miles from town this custom does not exist. Here the large number of haulers needed because of the longer distances involved makes it difficult to obtain a sufficient force of men to dispose of the wheat as fast as it is threshed.

In direct marketing the hauler loads the wheat into the cars by hand, by means of a scoop shovel holding about a fourth of a bushel. With the shovel he throws the wheat from the wagon into the car. This is hard and tedious labor. The loaded cars are then sent to the large milling or market centers, which, depending on the locality, may be Minneapolis, Chicago, Omaha, Kansas City, or St. Louis. When the car arrives at its destination, the purchasing company pays the current market price and remits by draft to the sender.

The theoretical advantage of this plan is the

elimination of the grain buyers, a class of men who are not producers but who profit by handling the wheat. In spite of its theoretical advantage the plan is not generally followed in practice. The reasons for this are: (1) results have not proved

FIG. 65. — Hauling wheat to market. Sometimes the family goes along.

better than when sold through organized dealers; (2) slower returns and greater risks are involved; (3) there is an inability to sell in less than carload lots; and (4) manual labor is necessary where car-loading devices are not provided.

*Marketing through Elevator Companies.* — The selling plan followed generally in the more important wheat regions of the United States and Canada is through the elevator companies. The farmers take their grain to the nearest town. There elevators have been built alongside the railroad tracks. These are so arranged that the load can be hauled into the building, weighed, and then dumped into a pit whence bucket elevators convey the grain into storage bins or cars. The whole process of weighing loaded wagon, unloading, and weighing empty wagon can be accomplished in four or five minutes. The elevator is also provided with a screening and fanning apparatus which removes the dirt and chaff from the grain and thus improves its market qualities. The storage capacities of

FIG. 66. — The elevator is a tall, towerlike building.

country elevators usually vary from 8000 to 20,000 bushels, although some are much larger. Gasoline or steam engines are used as power for operating the machinery.

The elevators are in charge of a buyer, known as a grain dealer, who grades each farmer's wheat and pays him as soon as it is delivered. This transaction completed, the farmer's direct interest ceases. He takes his money to use for living expenses, and the surplus is often used for buying equipment to raise more wheat. He buys more land or more up-to-date machinery, and in either case looks forward to increased production. He has made his contribution to commerce.

*The Market Grades of Wheat.*—The price received by the farmer depends somewhat on the quality of the wheat. The larger market centers have adopted standard requirements for different grades so that the wheat of commerce is now purchased and handled as No. 1, 2, 3, 4, or Ungraded. It is also classified as to whether it is Spring or Winter wheat and Hard or Soft. This classification further includes in a general way the color, — white or red. Thus a typical market description for Kansas wheat would be No. 2 Hard Winter Red.

The grade requirements are not uniform in all countries of the world, and not even closely uniform in the different market centers of the United

States. In a general way, however, the following is considered a fair statement of grade requirements, and illustrative of differences between the commercial grades :

*Classification of Wheat adopted at the Merchants' Exchange, St. Louis*

*Choice White.* — Bright, sound, dry, plump, and well-cleaned pure white winter wheat and to weigh at least 62 pounds per measured bushel.

*No. 1 White.* — Sound, dry, well-cleaned pure white winter wheat to weigh at least 60 pounds per measured bushel.

*No. 2 White.* — Sound, dry, white winter wheat reasonably cleaned, to weigh not less than 59 pounds per measured bushel.

*Choice Red.* — Bright, sound, plump, dry, and well-cleaned red or red and white mixed winter wheat to weigh at least 62 pounds per measured bushel.

*No. 1 Red.* — Sound, well-cleaned, dry-red or red and white mixed winter wheat free from rye, to weigh not less than 60 pounds per measured bushel.

*No. 2 Red.* — Includes all sound, dry, reasonably cleaned, red or red and white mixed winter wheat below No. 1 red and to weigh not less than 59 pounds per measured bushel.

*No. 3 Red.* — To include dry red, white or mixed, or bleached winter wheat free from must, to weigh not less than 57 pounds per measured bushel.

*Grading the Wheat.* — The local buyer in order to determine its grade is usually required to test a typical sample of each load. This is done by taking handfuls of wheat from different parts of the

load and filling a standard measure. The correct amount is obtained by heaping the measure and scraping off the excess by means of a straight-edge. The vessel used is generally in the form of a cylinder about $5\frac{5}{8}$ inches deep, $5\frac{3}{8}$ inches in diameter, with a capacity of two quarts. It is so graduated that weighing it by the steelyard scheme, the reading is given in pounds per bushel. The volume of a bushel is 2150.42 cubic inches and the standard weight in most states is 60 pounds. Where the weight of a volume bushel exceeds 60 pounds, the wheat is over weight, where it weighs less than 60 pounds it is under weight. Referred to this same standard, wheat is known as heavy or light.

In order to be full weight, the grains must be of good size and quality and the wheat dry and free from dust, chaff, and bits of straw. Since cleanliness is very important in affecting weight and appearance, and since both of these facts are considered in determining the market grade, the work of the thresher should be well done. In many instances the wheat delivered by the farmer to the elevator, because of insufficient cleaning, lacks just a little of belonging to a higher grade and a lower price results. In this event the grade can be raised by recleaning in the elevator, and the expense of the extra work is more than met by the increased price which is obtained for it. The

grain is bought at the grade shown by test, which grade the buyer, after the grain is his property, will try to improve. The reason for this appears when we know that each grade usually has a market value of two to three cents per bushel above that of the next lower grade.

While grading wheat follows general rules, experience is necessary to become proficient in the work. Much depends on the judgment of the buyer since he must be fair both to the seller and to the purchasing company.

*The Ownership of Elevators.* — In the earlier years the elevators were owned and operated by individuals. Many were ex-farmers who preferred business to active farming and thought it an easy way to make money. Others were business men attracted to that line of work. Some were highly successful, and those who lacked business sagacity or were careless in management failed. Competition between rival concerns in the same town or in near-by towns forced operators to buy on very close margins. The buyer purchased independently, making himself the owner of the wheat in transit to central market. If the price advanced he was the gainer; if it fell he suffered loss. Buying thus became intimately related to market tendencies, and many men failed because they did not guard against falling prices by buying with sufficient margin. When prices

were rising there was a tendency to buy on a margin so low that rise in price was necessary to avoid loss on the transaction. Sometimes the expected advance failed to come and the dealer suffered serious loss. When a sharp rise occurred

FIG. 67. — Loading freight cars for shipment from local elevators to central or terminal markets. In this case the elevator machinery was operated by steam.

the profit was large and this often stimulated a speculative desire which later frequently led to recklessness and disaster.

Individual ownership of elevators resulted in close buying, and hence full returns to the wheat grower. The competitive conditions, however,

did not endure, for the successful operation of one elevator enabled the owner to buy another from some one less fortunate and soon the advantage of organization became apparent. Companies were formed which bought all the elevators along a given line of railroad or in a certain territory. These became known as "line elevators." They were managed by men who were expert in following market conditions and who were able to find the best places to sell. The large volume of grain at their disposal was of advantage not only in securing the best prices but also in obtaining cars when needed.

A local manager was placed in charge of each elevator. His business was to weigh the grain, look after the mechanical work, and submit daily reports on the business done. He had no discretion as to prices, for daily instructions were sent from company headquarters. In the event of sudden changes in the market, telegraphic instructions were sent. An important task of the manager in this case was to keep the good will of the farmers.

Conservative buying, close watch of market conditions, and keen business methods throughout are strong arguments in favor of the extensive elevator companies. In some localities all the elevators passed into the hands of one company; and, since, having become accustomed to

selling to the elevator, the farmers would not sell by direct shipment, the company was thus given a virtual buying monopoly. The elevator, once established in the community, became a public service necessity. Monopoly of ownership often resulted in the charging of excessive rates, — in other words, buying at too high margin. This, of course, resulted in giving the producer a lower price than that to which he was entitled. Individuals were unable to remedy this since they could not compete with the powerful organizations. Many companies never abused their advantages and were content with the profits resulting from good business management. The abuses of some, however, placed nearly all of them under suspicion. Out of this condition grew the organization by farmers of local companies which built so-called "farmers' elevators." Since the strength of the concern lay in its membership, shares of stock were sold to as many farmers in a community as possible. The business of the local companies was placed in charge of a board of directors who hired a man experienced in grain dealing as manager. To him was intrusted the working out of details subject to the approval of the directors. Each subscriber pledged himself, if prices were equal, to sell to his own elevator. If the line elevator paid higher prices than the farmers' elevator he would sell there; in such case he

would probably pay a small percentage of the gain to his own company. This served to establish a fund which would tide it over dull periods. This fund was important, since it was planned that grain should always be bought at a reasonable profit and never at a loss. These conditions would insure competitive conditions for the line elevators. Although, early in the days of organization, many farmers' elevators failed because of poor management, the general effect has been good. At present they are usually successful throughout the Central states. Experience and organization have rendered them efficient. Competition is not now between individual elevators but between strong rival companies, and business methods have been greatly improved. Out of this condition greater economy and efficiency have resulted.

**Railway Transportation.** — Wheat in the elevator or in the cars is an article of commerce. Usually it has passed from the ownership of the producer to that of an agent who has in turn intrusted it to the carrier. Railways haul the wheat to mills, to central markets, or to terminal elevators. These elevators are usually situated where water transportation can first be employed. This carrying work is spoken of under two heads, the short haul and the long haul. The former includes shipments to local mills and from small

towns to the central markets; and the latter, the shipments from the central markets to the terminal elevators. The typical central markets for wheat in North America are Winnipeg, Minneapolis, Omaha, Kansas City, and St. Louis. These are all inland cities situated in the wheat country and are focal points of numerous railroads. The wheat in carload lots is shipped from adjacent territory, hence the term *short haul.* From these cities it is sent by trainloads to terminal markets or export centers. This involves greater distances and so the term *long haul* is applied. The principal terminal cities in North America are San Francisco, Portland, and Seattle on the west coast; Quebec, New York, Philadelphia, and Baltimore on the east; and Galveston and New Orleans on the south. Because they also have a large export trade by water route, Duluth, Chicago, and Buffalo are called inland terminals. The terminal cities which are located near the great wheat-producing districts likewise naturally receive a great deal of grain by short haul.

If distance is considered, the short haul rates comparatively are much higher than those of the long haul. For instance, the rate from central Nebraska to Omaha is 8 cents per bushel for a distance of about 200 miles, while the rate from Omaha to Galveston is only 11.7 cents per bushel for a distance of 1338 miles.

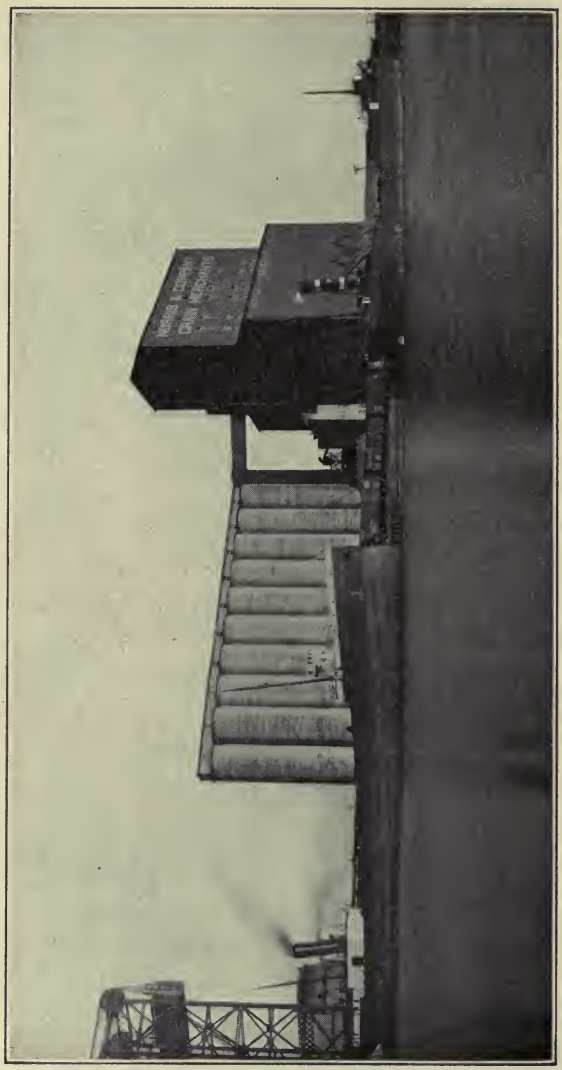


FIG. 68. — A terminal elevator at Chicago. Note the wheat pouring through the spout into the hold of the vessel at the right.

**Water Transportation.** — *The Great Lakes Highway.* — The Great Lakes, connected with the Atlantic Ocean by rivers and canals, constitute the greatest inland water highway in the world. It reaches deep into the interior of North America and practically touches the heart of the

FIG. 69. — A steamer carrying wheat for export.

wheat region. Lake Superior furnishes an easy outlet for the wheat areas of south central Canada and the north central United States, while Lake Michigan competes with the Gulf of Mexico for the trade of Oklahoma, Kansas, and Nebraska. The Great Lakes, connected with Quebec through the St. Lawrence, and with New

York City through the Erie Canal and the tidal Hudson River, are thus linked with the two east coast cities of greatest exporting importance. They serve to bring the markets of Europe nearer American producers since water freight rates, even where canals are used, are much cheaper than those of the railroads. This is clearly shown by comparison: for instance, the all rail rate on a bushel of wheat from Chicago to New York City in 1912 was 9.73 cents; by lake and canal it was 5.38 cents.

*The Mississippi River.* — The Mississippi River is the only other inland waterway in the United States of any great commercial importance to the wheat industry. It has, however, not been able to enter into very serious competition with the railroads. This is probably due to the facts that a comparatively short haul is involved, an indirect route is necessitated, and a considerable railroad haul is at any rate necessary in order to bring the wheat to river ports. In other words lack of navigable tributaries reaching into the wheat districts has proved a serious drawback to the commercial importance of the Mississippi River.

*Ocean Routes.* — For wheat, as for other agricultural products, the ocean is the great highway of water transportation. Since Europe furnishes the market for the greater part of the wheat exported from the countries of the western hemisphere, the

Atlantic Ocean has the distinction of being the greatest waterway in the world for this cereal. The freight steamers which are used in hauling the grain are immense slow-moving boats. They are loaded at the terminal elevators by chutes through which the grain slides into the hold of the vessel and are unloaded at the European seaports by electric shovels operating from cranes. But little hand labor is used and expenses are kept at a minimum. All this makes possible very low rates in comparison with railway charges. The freight rate from New York to Liverpool varies from 3 to 7 cents per bushel. From New Orleans to Liverpool it is from 6 to 15 cents per bushel. Wide differences in rates for the same haul are due to a lack of organization of ocean traffic. Rates are not regulated by any commissions. If a ship finds difficulty in obtaining a cargo, it will reduce rates. If shipping is active, rates are raised. Sometimes wheat has been carried from New York to European ports without charge because outward bound vessels had no cargoes in sight. It was cheaper to haul wheat free than to buy gravel to serve as ballast. This uncertainty of ocean freight rates does not help the farmer. Market prices always take into account the highest freight rate that is likely to be charged. If lower rates can be secured, the exporter is the gainer, not the wheat producer.

**The Terminal Elevators.** — At each of the central and terminal markets immense elevators have been built whose chief business is storage. They also serve to transfer grain from railroad cars to freight vessels. With their storage capacities, which vary from 500,000 bushels to 2,300,000 bushels, they serve as great reservoirs into which, during the market rush following the harvest, the wheat can flow and be held; and from which it can move as the milling and export trade demands. Companies operate these elevators for the profits which are derived from storage charges. They do not take the chances of speculation. When the elevator runs short of stored grain, the company is likely to buy enough to refill, but it immediately sells for future delivery with storage charges added. This is called *covering*. It not only removes the company from danger of loss due to falling prices, but also prevents the chance of gain as a result of advance. The grain may then change ownership many times and still remain in the same elevator. Sometimes it remains in storage in this way for a year or more.

**The Wheat Exchange.** — The buying and selling of wheat for future delivery has given rise at various places to speculative markets. The most famous of these in this country is the Chicago Board of Trade. Here many forms of farm products are handled, but wheat because of its

world relation is probably the most typical. A part of the exchange dealing with wheat is known as the wheat pit. The big wheat and flour men as well as the brokers dealing there are in close touch with all the wheat countries of the world. During the critical period preceding and during the harvest season, telegraphic reports give them detailed accounts of the wheat outlook. They are informed of approaching storms that may injure the crop. During all the growing season influences which tend to injure or improve the wheat are constantly reported. The price on the exchange is thus related not only to the visible supply, the stores of known wheat, but also to general world prospects for the future. Such a detail as the matter of prospective change in ocean freight rates to Liverpool, Constantinople, or Hong Kong will cause a price fluctuation. The dealers in the pit who are hoping for advance in prices are known as *bulls*, those who wish for decline as *bears*. If a man has bought wheat and desires to sell he naturally seeks an advance, hence he joins the bulls. On the other hand, a man, provided he puts up a sum of money to guarantee the contract, may sell without actually owning any wheat. Then he may sell a quantity of wheat at a high price when he expects the market to break or decline. This he hopes to buy back later at a lower price. Such a deal

depends for its success on lowering of prices and the group of men conducting it are known as bears. All this suggests, as is actually the case, that much more wheat is bought and sold than is ever raised. A large percentage of the sales conducted by the grain exchange is only on paper. Very little actual wheat changes hands. Yet the relation of the exchange to the markets is close since any of the deals which are made could be carried out should the seller prefer to dispose of the real commodity.

Conditions which affect the price of wheat are so numerous that dealing in wheat futures is as uncertain as that of stocks and bonds. Since the uncertainty has its fascination for many business men, there are times in the wheat pit of the Chicago Board of Trade which are as exciting as those in the Stock Exchange of New York City.

### Questions and Exercises

1. Why is exchange of wheat for flour not practiced much in the great wheat-producing regions?
2. What conditions in a region favor the development of numerous small mills?
3. Explain how short distances to market favor the selling of wheat direct from the thresher.
4. What difficulties have been experienced by farmers who have tried shipping direct to distant markets?
5. How is grain graded for market purposes?
6. What are the market grades of wheat?

7. Explain the functions of the elevator in wheat marketing.

8. What conditions led to the organization of *line elevators?* What advantages can you see in such an arrangement?

9. What are the farmers' elevators? What causes have led to the general organization of farmers' elevator companies?

10. What is meant by the terms *short haul* and *long haul* as applied to freight?

11. What are the chief central wheat markets in North America? Where are they located with respect to the wheat-producing regions?

12. What are the principal terminal cities for wheat exports in North America?

13. What ocean is of first importance in the wheat trade of the world? Why?

14. Of what importance are the terminal elevators in the marketing of wheat?

15. Briefly explain buying and selling in the wheat exchange.

# CHAPTER IX

## *MILLING*

**The Milling of Wheat.** — Perhaps no part of the story of wheat is more fascinating than that of milling. Very little whole wheat is used for food. Practically all of it is ground in some manner, and the parts of the grain are separated before it is prepared directly for the table. The processes of making flour and other wheat products are exceptionally interesting. This interest may be due, in part, to the fact that milling was the operation in the wheat industry which first was done outside the home. The necessity of more power for the operation of the mill than could be supplied in the home favored the establishment of village mills, and this method very early became the prevailing form of the industry. These mills were usually located where power could be derived from a stream or from the wind, although, sometimes, cattle or horses were used. They came to be known as gristmills, because the miller was paid by taking as toll a part of the grain, giving back to each customer the rest of his wheat as

flour and bran. The miller thus became an important and respected personage in the community,

FIG. 70. — An old mill by a stream.

the people being dependent upon him for an essential food. Then, too, the stability of his business usually made him well-to-do. Many

writers have eulogized the miller and given voice to his sturdy character. The familiar *Miller of the Dee* is one of the many examples, where an author has made clear the popular figure's character and standing.

> "There dwelt a miller, hale and bold,
> Beside the river Dee;
> He wrought and sang from morn till night,
> No lark more blithe than he."

The poet tells of the miller's discussion with the king in which the king says,

> "'Thy mealy cap is worth my crown,
> Thy mill my kingdom's fee!
> Such men as thou art England's boast,
> O Miller of the Dee!'"

Modern methods of handling the wheat and the development of a variety of industries has produced many changes and has lessened the old close relation among producer, consumer, and miller. Most farmers now sell their wheat to grain buyers and in turn buy flour from the stores as they need it. Gristmills are, however, still operated in some sections. Peculiarly enough, the character of the miller has not changed greatly and he is still held in much the same regard as of old.

**Primitive Milling.** — *The Handstone.* — It is interesting to learn something of the stage of devel-

opment of different peoples as indicated by their methods of milling. The handstone is used by some Indian tribes. Here the grain is placed in a hollow stone and the women pound it with another stone. The grain by this method is not reduced to a powder, but is merely broken into rough fragments. This is undoubtedly one of the most primitive methods and seems to be the one early used by all peoples, for specimens of these handstones are found in many parts of the world. Some tribes use two stones so shaped that they may be easily handled. The crusher is oval and the container is rounded and deep. When of such forms they are called the mortar and pestle. The latter sometimes has a handle made of wood. This form of mill was used for many years by the early settlers of Plymouth, Massachusetts. In these primitive methods the milling was done by the women.

FIG. 71. — The handstone used in grinding wheat.

*The Quern.* — In parts of Europe and Asia the quern is used. This is an improvement over the handstone and also over the mortar and pestle. In this method the two stones are mechanically united so that the upper stone fits into and revolves upon the lower. A hole is bored in the side of the upper stone and a handle inserted by which it is turned. Another opening at the top admits the grain, which passes through a hole to the lower stone. There, as the upper stone is turned in a half circle, the grain is crushed. This motion likewise works the crushed grain to the edges, whence it drops into a bowl or other container. In early times the women usually did this work with the smaller querns, while cattle were used to turn the larger ones. This method came into general use about the dawn of the Christian era. It was the first British flour mill and is also men-

FIG. 72. — The quern.

tioned in early American history. The handstone, mortar and pestle, and quern, thus, all belong to the type of mill in which grinding is the method of reduction and human energy is practically the only power. In ancient times the work in each method was largely done by women. Later on, however, slaves and criminals were used.

*Buhrstone Mills.* — Buhrstones, or millstones, used by small mills in almost every country, represent another type of milling. By this method the grain is cut and crushed and emerges as a much finer product. The surface of each stone is cut so that the grooves of one fit into those of the other, and by the sharp edges of these grooves the grain is cut to pieces. The power used is from cattle, wind, or water. Sometimes they are run by steam power or electricity. These mills are larger than the quern and others previously described. The grain is ground for the village or community, the miller charging a toll for grinding.

These simple mills were common in the early history of the United States, and the improved gristmill was the prevailing type until about 1880. Small mills were located wherever water power was available. Towns near power sites served as locations for the larger ones. In general, mills were scattered and they were of moderate size. As population and wheat production increased, it became necessary to produce more flour. Mills

with several pairs of stones then became common. During the period immediately after the Revolution, the flour mills of Delaware were among the best known. Twelve mills upon the Brandywine, with 25 pairs of buhrstones, ground 400,000 bushels a year. Improved methods of handling the grain and flour were also invented. About 1785 the elevator and conveyer were introduced, thus eliminating much hand labor. Development was so rapid that in 1808 Pittsburg had a steam mill with three pairs of buhrstones.

**The Development of Modern Milling.** — The roller mills, which use the gradual reduction process in the manufacture of flour, represent the modern type. Though they were not introduced until about 1880, they have now come into general use in all the great milling centers of the world. This process of milling originated in Austria, and it is interesting to review the problems that led to its adoption in the United States. In the old processes, the millstones were at first set very close together so as to produce as much flour as possible at one grinding. This produced friction and heat and often brought about chemical changes which injured the color, taste, and quality of the flour. Wheat, which was hard and rich in gluten, could scarcely be used at all, for it was difficult to separate the flour from the bran. The soft starchy wheats thus brought the high prices

since when they were used the bran was more easily separated and the flour was whiter.

The opening of new wheat regions in the Northwest, where large quantities of hard spring wheat were produced, increased the demand for other milling methods. A method was required which would produce a good flour from their product. The first step toward this end was the invention of the middlings purifier. This is a method, which, during the milling process, separates the parts of the kernel. The middlings are the coarse particles coming from the part of the kernel between the bran covering and the starchy central part. In the old process middlings were avoided, and as much flour as possible was obtained from the first grinding. Now by setting the stones far apart the purpose is to make at the first grind a large percentage of middlings and to eliminate the bran and first flour, which is of a low grade. The middlings, which are then purified and reground, make the high grade flour. By this method the hard spring wheat gave a high percentage of middlings and immediately came into favor.

The increasing number of *breaks* that became necessary, though, demanded improved machinery. Representatives from the leading mills in the United States visited Europe and there studied the Hungarian methods of milling. This study resulted in the adoption of a roller system

of machinery which, with many improvements, has come to be the modern process. By this method the grain, instead of being ground in a single pair of millstones, is run through six or seven sets of rollers and is sifted and graded after each break. The first pair of rollers are so far apart that they merely crack or break the grain. The second pair are a little closer together, the third pair still closer, and thus they continue, the distance between them being decreased with each successive pair. The old process aimed to get as much flour as possible at one grinding; the new seeks to get as little flour as possible at the first two or three breaks. The old process sought to avoid middlings because they meant loss of flour. The new process seeks to produce as much middlings as possible, because the high grade flour is produced by grinding them. By the old process but little of the gluten could be separated from the bran, which resulted in a weak flour since gluten gives it its rising quality. By the new method of milling a large part of the gluten is saved and thus a better flour for bread making is produced.

In order to understand clearly the processes of modern flour making we should visit a mill. There by close observation and study we may gain a clear idea of how flour is made. To prepare ourselves, let us together make an imaginary trip, then if possible, follow it with an actual one.

**A Visit to a Large Mill.** — As we approach the milling plant, we find ourselves contrasting the group of four or five factory-like buildings with the picturesque mills of the artist. These, with their huge vanes and great water wheels, do not harmonize with the matter-of-fact group before us. There is but little of the poetic in the build-

FIG. 73. — A modern milling plant.

ings, — the power house, warehouse, elevator, and mill.

We enter the office and ask if we may see the mill. We are pleased when the miller himself comes in to act as our guide. He is still the "dusty miller," for his white suit and white skull cap are covered with flour. He is pleased to take us through, for he is proud of his mill. We follow a winding stair to an upper floor. Here he shows us how the wheat is received, cleaned, and tempered. No one needs to be there for the work

is all done by machinery. We are here shown several purifiers and dust collectors also. There is so much noise that it is hard to hear explanations. But we are interested in the dust collector, for we have read that in the old-time mills there were disastrous explosions caused by the fine flour dust which filled the air. We resolve that later we shall find out more about this.

Now we hurry down to the other floors to see the processes of reduction. Two floors are occupied by mills and screeners or scalpers. As we pass along we see them labeled: 1st break, 2d break, 1st middlings, and so forth, each machine in turn labeled to indicate its special function. We watch the material through a glass window as it comes in to each machine; and, by opening a small door below, we catch some of the product as it leaves and note what change has taken place. We find that the products are transferred from floor to floor by conveyers. Very few assistants are about. We see one going from place to place and are told that he is making tests. The flour is tested at every stage of the process, for it must be uniform from day to day.

Then we are taken to see the bolting. At first we are afraid to enter the room for the shaking bolters make us dizzy. We soon get used to them, however, and immediately become interested in the silk bolting cloth which the miller is

explaining. It is so finely woven that it seems impossible for flour to go through it. He shows us how screens made of this cloth are fitted into the great tank-like cases, which are really silk bottom sieves. These are shaken by machinery, and thus the flour is sifted through the cloth. This process is called bolting.

Coming down again to the first floor, we stop for a while to watch the sacking of the flour. The sacks are stamped with the name of the mill and the grade of the flour. They are filled automatically. Men, however, handle the filled sacks and sew them up. We stay here for some time, for this is fascinating work. The man lifts the sack from the filler and weighs it. He then takes a thread from his belt and, threading it through the needle, wraps it about one corner of the top of the sack, thus making an ear. Lightning-like he sews up the opening, makes the other ear, takes off the remaining thread, and lifts the sack to the truck. This is all done so quickly that we hardly distinguish the processes. It looks like a sleight-of-hand performance and we remain until we can follow his rapid movements.

The miller tells us that many large mills turn out 1500 barrels of flour per day. This, compared with the few bushels of poorly ground meal that the old mills produced, is enormous.

Our tour of the mill is finished. We feel that

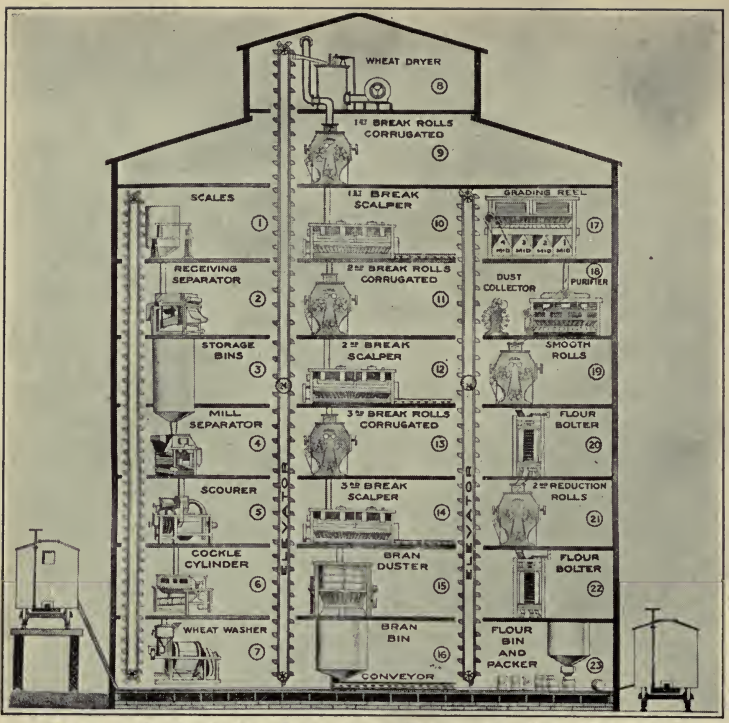



FIG. 74. — Sectional view of a modern mill: *1*, scales, for weighing wheat as it is received; *2*, receiving separator, for separating other kinds of seeds from wheat; *3*, storage bins, for reserve supply of wheat in advance of mill requirements; *4*, mill separator, for further separating foreign seeds from wheat; *5*, scourer, for removing dust from wheat kernels; *6*, cockle cylinder, for removing all round seeds; *7*, wheat washer, for thoroughly cleansing the wheat; *8*, wheat dryer, for drying wheat after washing; *9*, first break rolls, for rupturing bran, enabling bran and germ to be separated from interior; *10*, first break scalper, for sifting middlings through bolting cloth to separate from bran; *11*, second break rolls, for further loosening the middlings from bran; *12*, second break scalper, for separating more middlings from bran; *13*, third break rolls, for further loosening middlings from bran; *14*, third break scalper, for final separation of middlings from bran; *15*, bran duster, for sifting low grade flour from bran; *16*, bran bin, for packing bran for shipment; *17*, grading reel, for separating middlings by sifting through various sizes of bolting cloth; *18*, dust collector and purifier, for cleaning and purifying middlings by air and sifting; *19*, smooth rolls, for grinding purified middlings very fine to flour; *20*, flour bolter, for sifting flour from purified middlings; *21*, second reduction rolls, for further grinding of purified middlings; *22*, flour bolter, for separating flour from purified middlings of second grinding; *23*, flour bin and packer, for packing flour for shipment; *24*, elevator, for raising products to the various machines.

we have seen so much that we must think it over carefully before we can understand it all. We brush the flour from our clothes and thank the miller for his kindness. We leave, realizing more fully than we did before that milling is no longer a simple home industry, but that it is, rather, a complex factory system which supplies millions of people with one of their most common food materials.

This has given us a bird's-eye view of the processes of flour making. As yet, we hardly understand why so many steps are necessary. In our hurried trip, we could not stop to learn the whole story of each process. Let us now study them more in detail.

*The Mill Elevator.* — In order to keep busy at all times a supply of wheat must constantly be kept on hand. This is stored in a tall building called an elevator (Fig. 73, building to the right and rear). The capacity of this elevator may be large or small. It usually corresponds in this respect to the size of the mill. A surplus is also carried because it is of business advantage to buy when wheat is at a low price. The grain may be purchased either in carload lots from central markets or in some cases directly from the farmers.

*Cleaning the Wheat.* — The wheat is brought to the mill from the elevator by a conveyer. The miller knows that in order to have a high grade

product he must start with clean grain. The first step, therefore, is to separate the wheat from husks, dirt, weed seed, and other undesirable matter. This separating is accomplished by screening processes. After screening, the grain goes through scouring machines, where wheat hairs, loose particles of bran, and any foreign matter which may be clinging to the kernels is removed. Some millers even wash the wheat during the scouring process.

*Tempering the Grain.* — The grain thus purified and cleaned must go through a tempering process. The purpose of tempering is to put the grain in the best possible condition for milling. Just what this condition is depends upon the product desired and the details of the milling method used. Heat and moisture are always applied in some form. Tempering toughens the grain and so conditions it that, in grinding, the bran will remain in large pieces and the various parts of the interior will break up in such a way as the miller may desire.

*The Reduction Process.* — After the tempering process the wheat is then passed through six or seven sets of steel rollers, the first sets of which are corrugated. Each passage through a set of rollers is called a *break*. The rollers must be kept cool since, if the flour is heated during the process of reduction, it becomes dark. After each break the product is sifted through silk screens. The

parts removed, called middlings, are sent through the purifier. The part which does not go through the screen goes on to the next break. Since the first break rollers are set far apart, the grain is here merely flattened and slightly broken up. The sifting gives a small amount of fine flour. This comes from the center of the grain and, as has been previously stated, makes a poor grade flour. This is sent through the purifier, which removes particles of bran, fuzz, and dirt, and the product is called first break flour. First break flour is not added to the middlings but is sold as a low grade flour. Sometimes it is added to the shorts and used for animal feed.

After the first separation the bulk of the grain is still left and goes through the second break. The rollers here are closer together and other parts of the interior of the grain break down under this process. These parts are separated by sifting and the product here is known as second break middlings. This, in turn, is sent to a purifier. The remainder, which now looks quite like bran, goes to the third break, which reduces other portions of the interior of the grain so that they may be separated as third break middlings. Inasmuch as this process continues through 6 or 7 breaks, practically all of the interior part of the wheat grain is broken and removed, leaving the tough outer part as *bran*.

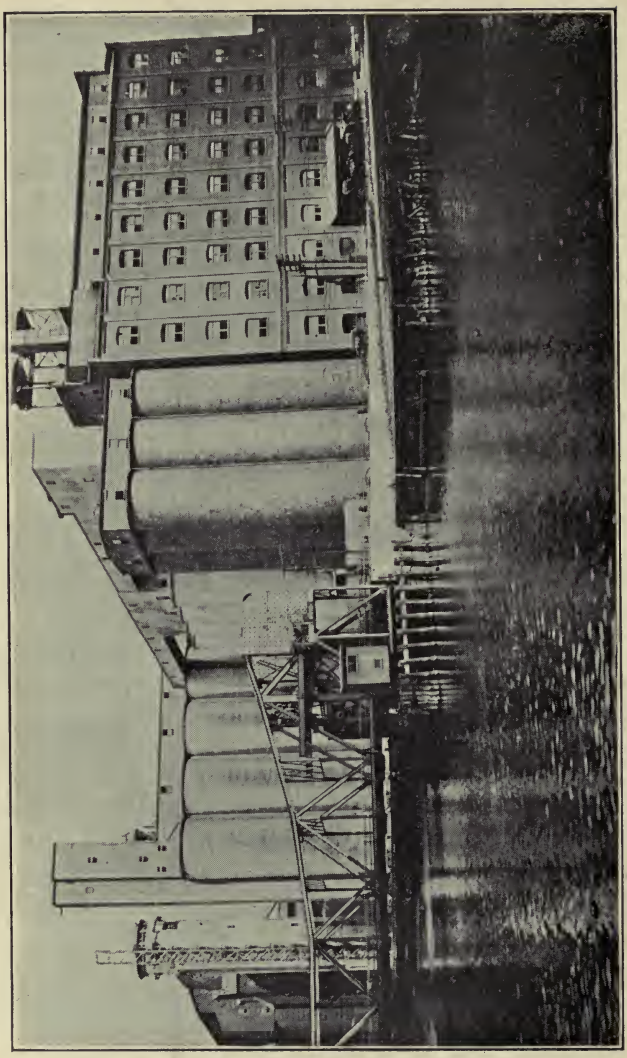


FIG. 75. — A large mill at Buffalo, New York.

The middlings from the various breaks, after going through the purifier, are further reduced by being passed between several sets of smooth rolls. The flour product of each reduction is then bolted. This consists of sifting the flour through silk screens of closer and closer texture, until a very fine-grained flour is the product.

*Bleaching the Flour.* — The flour from some wheat as it comes from the bolters is dark. Whiteness in flour is as much desired as is whiteness in sugar or yellowness in butter. The demand by buyers for a white flour has brought about the bleaching process. Under the old method the flour had to be stored for about three months in order to whiten it. This was a natural bleaching process, but it was very slow. Flour that was to be sent abroad could be bleached in this way, as it would whiten during the period of transportation, but a method which required a shorter time was deemed a necessity.

The Alsop process, invented by Alsop in 1904, is the one now generally used in the big mills. In England it is known as the Andrews method. Its advantage is that it prepares the flour for immediate use and thus saves the expense of storing. The treatment consists of subjecting the flour to the action of nitrogen peroxide, a gas which is made up of nitrogen and oxygen chemically united. As the flour in a thin stream is emptied into the

bleaching chamber, it is sprayed with air which contains this chemical. Nitrogen peroxide has the property of decolorizing the oil in the flour. How the flour is actually affected by this method of treatment has been a matter of dispute ever

FIG. 76. — General view of the

since it first came into use. In 1910, the Lexington Milling Company of Lexington, Nebraska, shipped 625 sacks of bleached flour to Missouri. The question was then brought into court by government inspectors. It was claimed that the flour contained foreign injurious substances and was thus in violation of the pure food law. Four years were spent in preparation for the case and

finally the court decision was announced by Justice Day on February 24, 1914. The court held that there was no injurious effect observed from the use of this bleached flour. This decision of the highest court was a great victory for the

Minneapolis milling district.

millers of the country. It permits them to ship bleached flour to other states without violation of the pure food laws.

**The By-products of Milling.** — The leavings from the various screenings and boltings consist of bran, the germ, and a low grade flour. The two latter products mixed together are known as shorts. Sometimes the germ and a part of the flour screen-

ings are put into the bran. Each miller has his own plan, being influenced by the market for the product. The germ, though high in food value, must be removed from the flour since it contains much oil. This oil would in time become rancid and thus affect the keeping quality of the flour.

**The Development of Milling Centers.** — In about 1835, the mills of Rochester, N. Y. were taking first place among the mills of the United States. Rochester was surrounded by about 2300 square miles of fertile valley land which was producing wheat that took prize medals in European exhibitions. The Erie Canal, Genesee River, and Tonawanda Railroad brought to the Rochester mills not only the wheat of this valley but also that of Ohio and Canada. Within the city limits of Rochester the Genesee River has successive falls aggregating 268 feet. These wonderful falls serve as a great source of power for milling. Rochester because of these natural advantages came to be known as the Flour City.

The next milling centers to develop were to the west and south. By 1865 the leading wheat-producing states were Illinois, Indiana, Wisconsin, and Ohio. Transportation was down the Mississippi to New Orleans. St. Louis thus developed as a receiving and milling center, and held first place until 1880. Surrounded by wheat-producing areas, with easy transportation in all direc-

tions, it has maintained a large and steady milling trade since that time.

The introduction of the middlings milling system stimulated the production of spring wheat in what was then called the Northwest. The millers of Minneapolis being in that locality were among the first to adopt roller machinery. The development and rapid growth of their mills was remarkable. The Red River valley has been called "the bread basket of the world," and Minneapolis controls the gateway to it. With the power in the falls of St. Anthony, the nearness to the wheat country, and the transportation conveniences, the result was inevitable. Minneapolis is now the greatest flour-producing center in the world.

### Questions and Exercises

1. What is meant by a gristmill?
2. Why are the handstone and the quern referred to as primitive milling devices? Where are they in use now?
3. What methods of milling were in common use about the time of the Revolutionary War?
4. About when were modern milling methods introduced?
5. What are the essential differences between the old buhrstone methods and the present gradual reduction processes?
6. Why do many mills have large wheat elevators as part of their equipment?
7. How is wheat made ready for grinding into flour?
8. Describe the essential processes in manufacturing

flour. What is meant by *break?* Why are so many breaks necessary?

9. What are the by-products of milling?

10. What is the purpose of bleaching flour?

11. Trace the development of milling centers of the United States.

12. If possible visit a flouring mill and write a story, tracing the wheat through the various processes of manufacture into flour.

# CHAPTER X

## *THE USES OF WHEAT PRODUCTS*

WHEAT is so closely associated with flour and bread in our minds that we do not think of its other products and uses. Among the products of wheat, bread, because of its importance in the diet of all civilized people, will, no doubt, always have first place. Some parts of the wheat, how-

FIG. 77. — Some farmers burn their straw stacks.

ever, cannot be used as flour, and likewise certain wheats have been found to be better adapted to the manufacture of other products. The demand for variety has also led to the manufacture of many less common wheat foods. Furthermore straw has various uses both in feed and in manufactures. Thus we see that wheat and its products enter into many industrial activities.

**How the Wheat Straw is Used.** — In the big wheat regions thousands of tons of straw are burned every year. Smaller wheat districts burn 25 to 75 per cent of the straw. This makes of the straw almost a total loss and therefore such a method can be only temporary. Although there are many minor uses for straw, no means of utilizing the bulk of the product has yet been generally accepted.

FIG. 78. — A straw stack placed at the head of a gully to prevent erosion.

Some farmers scatter the wheat straw over the fields as a top dressing in order to prevent the blowing of the soil. Sometimes the grain stacks are placed in groups near gullies; and, as the threshing is done, the straw is piled into them to prevent erosion. The straw stacks tend to check the water in the gullies and so prevent their further growth. Others place the straw on lower parts of the land, then plow deeply, and thus improve the drainage. These methods of using straw are all better than burning it.

Wheat straw is fed to farm animals as a fodder. It is low in protein and fat and high in carbohydrates. Its composition suggests that it has much food value. This, however, is not the case, since to digest and assimilate the nutrients in the wheat straw, it takes practically as much energy as it furnishes. When other feed is scarce a good deal of straw, however, is fed. Although it has but little fattening value, it may be valuable in carrying stock through a period of famine.

*Dry Matter and Digestible Food Materials in 100 Pounds of Straw*

| Feeding Stuff | Total Dry Matter | Protein | Carbohydrates | Fat |
|---|---|---|---|---|
| Alfalfa Hay | 91.6% | 10.58% | 37.33% | 1.38% |
| Wheat Straw | 90.4% | .37% | 36.30% | .40% |

In general the chief value of the straw lies in its use as a fertilizer and an increasing amount is so used each year. The nitrogen, phosphoric acid, and potash which it contains are the important constituents which growing plants need. If purchased as commercial fertilizer, the amount of these elements which is found in a ton of wheat straw would cost about $2.50. On this basis the straw from an average 40-acre field is worth $100. This is a much higher value than can be obtained from any of the other uses that we have discussed.

Straw that is to be applied as fertilizer serves a double purpose. It is first used as bedding for stock and is then returned to the soil as a manure. Experiments upon lands that have been fertilized in this manner have usually shown a decided increase in crop yields.

Wheat straw is also used in a number of manufactured articles; for example, mattresses, doormats, paper, and hats. Straw pulp for the manufacture of paper is also an important article of commerce. The production of wood pulp, however, has lessened this use of the straw, since the wood pulp is cheaper and is more easily utilized. The manufacture of straw pulp is now practically confined to Germany. It is used for the purpose of making cheap printing paper harder and more opaque. Manufacturers of straw hats likewise depend largely upon wheat straw for their raw material. The finest straw for this purpose comes from the vicinity of Tuscany in Italy. There the

FIG. 79. — After the wheat has been cut, weeds and grasses spring up in the stubble, affording autumn pasture.

straw is an important product of the wheat plant. The plaiting of the straw, furthermore, gives employment to thousands of women and children. Most of the plaits are sent to the factories of England and some are imported by the United States.

**Wheat Grain as Stock Feed.** — Wheat grain not only is relished by all kinds of farm stock but is a valuable food. It is only within recent years, however, that it has been so used to any great extent. Since it costs more to produce wheat than corn, wheat is not likely to become common stock feed, but there are times when it can be profitably used. A shortage of corn and an overproduction of wheat may bring about market conditions that would warrant its feeding. Damaged wheat, likewise, should be fed rather than sold at a low price; for, although the flour value, which determines the price, may be very low, the feeding value may be high. Wheat is fed as an appetizer by mixing it with other grains. Since it is so hard it should usually be ground or soaked before feeding.

In the milling of wheat for flour, several by-products are produced. These are usually known as shorts and bran, and are important stock feeds. Their composition varies in products from different mills. In general, shorts contain most of the germ and the screenings from the various

grades of flour. Bran is composed of the outer coats of the kernels and of such portions of the inner parts as are not separated in the milling processes. The scourings from the grain are usually added to the bran. Shorts and bran are both concentrated stock feeds.

**Wheat as a Food.** — The wheat grain has its largest use as a human food and in this capacity has rapidly replaced the other grains. This is due to its palatability rather than to its superiority in sustaining life.

Sometimes the whole wheat is used. In this case the grain is cleaned and cooked until it is soft and then served with milk and fruits added. This was the primitive method of preparing wheat. Now it is usually more or less broken up and separated according to its composition.

**The Use of Wheat for Macaroni.** — Macaroni is an Italian preparation. It is made from hard wheats, which have a high gluten content. They are often called macaroni wheats, of which Durum is a typical example. They are grown in nearly all the wheat-producing countries. Some of the very best macaroni wheats are grown in Russia and Italy. Although originally an Italian industry, macaroni is so widely used that many countries are now manufacturing it. In the United States, from home-grown Durum wheat, about 100,000,000 pounds of macaroni are made annu-

ally. This quantity supplies only about one half the demand. The industry is growing rapidly, however, and the products are being widely advertised as " the best in the world," and " made in America from American-grown wheats."

*Copyright by Underwood and Underwood.*

FIG. 80. — Drying macaroni in the open air, Naples.

In the manufacture of macaroni the grain is ground into a coarse granular product, called *semolina*. This is put into a large mixer and boiling water is added. The mass is stirred and then kneaded into a dough. This is put into a cylinder

which has a perforated plate at the bottom and is then forced through this plate. As the strings of dough appear they are cut into desired lengths and are then hung over poles or are spread out on tables to dry and temper. There are various names for the different forms of this substance. If fine threads have been produced it is known as vermicelli; if it is in the form of thin sticks or pipes it is called spaghetti. Sometimes the dough is rolled thin and shaped into various forms as stars or discs. These forms are baked and are sold either in package or bulk under the name *paste*.

Some of the macaroni made in European cities is sun dried. It is placed on racks which are sometimes left out in the streets until the product is dry. This unsanitary method has been severely criticized and so in recent years there has been much improvement.

Most of the macaroni factories in the United States are models of cleanliness. Their product is kiln-dried and is handled by machinery. The label, "Made in the United States," indicates high quality in macaroni.

*The Use of Wheat in Cereal Foods.* — The manufacture in commercial quantities of cereal foods made from wheat is of American origin. The production of such foods is a prominent industry in Battle Creek, Michigan, and in Niagara Falls, New York. The high favor gained by cereal foods

has caused manufacturing plants to be established in a great number of other cities throughout the country. This is especially true of the Mississippi Valley region. Since the germ portion of the grain is a by-product in milling, flouring mills have frequently found it profitable to produce certain kinds of wheat foods, particularly such as make use of this germ portion of the grain.

Wheat foods are of many kinds: those which are whole wheat and those which use but parts of the kernel; those which are cooked and those which are uncooked. All are in general favor. The reasons for their popularity are not hard to find. Not only are they nutritious, palatable, and inexpensive, but they are readily and quickly prepared for table use. Because of their dryness they are also easily kept fresh.

The factories where these cereal foods are made are generally very sanitary. In the first process all dirt and other foreign matter is removed and the wheat is thoroughly cleaned. This cleansing is accomplished by sifting, fanning, and scrubbing. Then the clean wheat goes through the various processes of preparation and finally the product comes out ready for market. In the whole process of preparation it has not been touched by human hands. Even packing the food into the cartons or packages is in nearly every instance done by machinery.

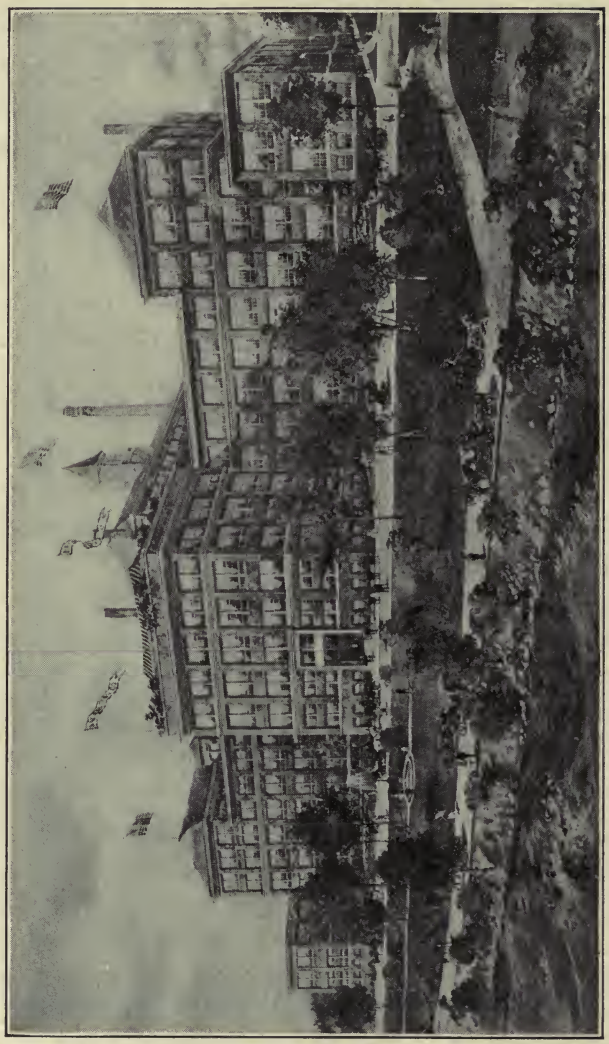


FIG. 81. — A modern sanitary wheat food factory.

*Total and Digestible Nutrients and Fuel Value of Wheat Breakfast Foods*[1]

| Name of Food | Proportion of Total Water and Nutrients in Food | | | | | | Proportion of Digestible Nutrients in Food | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Water | Protein | Fat | Nitrogen Free Extract | Fiber | Ash | Protein | Fat | Carbohydrates | Ash | Fuel Value per Pound |
| | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Per Cent | Calories |
| Whole Grain . . | 10.5 | 11.9 | 2.1 | 71.9 | 1.8 | 1.8 | | | | | |
| Cracked Wheat . | 10.1 | 11.1 | 1.7 | 73.8 | 1.7 | 1.6 | 8.1 | 1.5 | 68.7 | 1.2 | 1501 |
| Rolled Wheat, steam-cooked . | 10.6 | 10.2 | 1.8 | 74.1 | 1.8 | 1.5 | 8.5 | 1.6 | 70.7 | 1.1 | 1541 |
| Flaked and crisped, ready to eat . . . | 9.4 | 12.2 | 1.4 | 72.7 | 1.9 | 2.4 | 8.9 | 1.3 | 67.9 | 1.8 | 1500 |
| Flaked, crisped, and malted, ready to eat . | 9.0 | 12.1 | 1.4 | 73.0 | 1.8 | 2.7 | 9.1 | 1.3 | 68.4 | 2.0 | 1526 |
| Coarsely ground, parched at factory . . . | 8.0 | 14.2 | 3.1 | 72.3 | 1.0 | 1.4 | 11.5 | 2.8 | 70.1 | 1.1 | 1699 |
| Shredded Wheat | 8.1 | 10.6 | 1.4 | 76.0 | 2.1 | 1.8 | 7.7 | 1.3 | 71.1 | 1.4 | 1521 |
| Farina . . . . | 10.9 | 11.0 | 1.4 | 75.9 | .4 | .4 | 8.9 | 1.3 | 72.9 | .3 | 1609 |
| Crumbed and malted . . . | 5.6 | 12.2 | 1.0 | 77.6 | 1.7 | 1.9 | 9.1 | .9 | 73.7 | 1.4 | 1923 |

Cereal foods of all kinds have been extensively and ingeniously advertised and those made from wheat have been given particularly wide publicity. The claims sometimes made for them are astonishing. When these foods first appeared on the market, it was impossible to tell whether such claims were true or fanciful. Investigators at

[1] U. S. Dept. of Agriculture, Farmers' Bulletin 249.

experiment stations have studied their composition and food value so that now definite information about them is available. The composition of the various cereal foods made from wheat is about the same. There are slight variations because of differences in the grain used and in methods of preparation. The main differences are in appearance and flavor. The table on page 177 shows the average composition of the various breakfast foods, the proportion of digestible nutrients which they supply, and their energy values.

Because there is a bewildering number of trade names, there has been no attempt made to use them in this table. Instead there are used descriptive terms which correctly group the foods and answer the same purpose. An examination of any special brand as to its appearance and physical characteristics will determine the class in which it is included. A study of the table shows that these foods are dry materials, for the average water content is only about 10 per cent. They are rather high in protein and are especially rich in carbohydrates.

*The Use of Wheat for Flour.* — The uses of wheat thus far described are of minor importance if we take into account the quantities consumed. The great bulk of wheat is made into flour which is used not only in making bread but also for a variety of less important foods. Because of differences

in the wheat and in methods of milling, there are many kinds and grades of flour.

*Flour made from Hard Wheat.* — Hard wheat flour is the great bread flour. This fact is not due to any especially high nutritive value but to the fact that bread made from it is, on account of its lightness, easily digested. The gluten content of a flour largely determines its bread-making qualities. When water is added, the gluten binds the particles of flour together and the dough, instead of being flaky, as in soda biscuit dough or pie crust, is made tenacious. This gives it ability to expand. If, on the other hand, the flour contains too much gluten, the dough is sticky. It is gluten in dough that gives it the quality of stretching and rising as the gas from the yeast develops within it. Thus a light loaf is made.

*Flour made from Soft Wheat.* — Soft wheat flour has more starch and less gluten than that which is made from hard wheat. It has its greatest value in the making of foods in which tenacity and expansion are undesirable or unnecessary. Soft wheat is better for crackers, cake, and pastry. Bread made from this flour is white, but is likely to be heavy.

*Flour made from Durum Wheat.* — Durum wheat flour is very high in gluten. It is used chiefly in the manufacture of macaroni. Dough made from Durum flour is sticky and hard to handle. The

bread is yellow and has a peculiar, nutty taste. It holds moisture better than bread made from other flours. Durum flour is likewise of value in blends. The successful blend does away with the stickiness of the dough and lightens the color. It gives a moist bread of good flavor. Although the grain is so hard that it has presented difficult problems, the use of Durum flour has increased rapidly in the last few years. When the problems of milling and baking are overcome, Durum wheat will undoubtedly come into much more general use.

*Graham Flour.* — Graham flour is simply wheat meal; that is, the entire grain ground into a powder. Since the branny portions will not reduce as easily as the inner parts, they remain coarse. To overcome this objection, the bran is sometimes ground separately. Graham flour is also used chiefly for bread. We frequently hear that bread made from graham flour is more nutritious than that made from white flour. Experiments and tests seem to show that, since nutritive value depends upon composition and digestibility, white flour yields the more nourishment. There is not, however, a great difference. Graham flour has high protein content, but also contains a large percentage of indigestible matter.

*Whole Wheat Flour.* — Entire or whole wheat flour suggests a product identical with the graham. This is not the case, however, for, in whole wheat

flour, the outer branny layers of the grain are removed. Entire wheat flour is also not as coarse as graham. Much of the so-called whole wheat flour is merely a mixture of patent flour, middlings, low grade flour, and germ. Bread made from this flour yields more energy than that made from graham and less than that made from white flour.

*Composition of Breads as shown by Experimental Studies* [1]

| Material | Protein | Fat | Carbohydrates | Ash |
|---|---|---|---|---|
| *Bread made from Oregon Wheat Flour.* | | | | |
| Standard Patent . | 8.32% | 1.37% | 88.93% | 1.38% |
| Entire Wheat . . | 9.49% | 1.82% | 87.24% | 1.45% |
| Graham . . . . | 9.94% | 1.83% | 85.72% | 2.51% |
| *Bread made from Oklahoma Wheat Flour.* | | | | |
| Standard Patent . | 16.24% | 1.02% | 82.03% | .71 % |
| Entire Wheat . . | 18.06% | 1.77% | 78.75% | 1.60 % |
| Graham . . . . | 18.43% | 1.94% | 77.12% | 2.51% |

*White Flour.* — White flour is the flour which is most widely used. It contains about 73 per cent of the kernel of the wheat. The germ and the bran are both removed in the milling and the remainder is made very fine by repeated grinding

[1] U. S. Department of Agriculture, Farmers' Bulletin No. 389.

and bolting. It makes a whiter, lighter loaf than is made by either graham or entire wheat flour.

There are many brands and grades of white flour. By sorting the various parts of the wheat during its reduction, each mill produces several grades, all of which differ in composition and texture. The highest grade is called Best, Fancy, Patent, or some similar name. Other grades are Standard, Choice, and Family. The several grades manufactured by each miller are peculiar to his mill. These differences are due to the physical and chemical character of the wheat used, to milling methods, and to the skill of the miller. Each miller must keep his products uniform so that the baking qualities of the different grades of flour will remain constant day by day. Bakers are so particular about this that they test each fresh lot of flour and report any variation in quality that they find. The housekeeper likewise prefers a brand with uniform bread-making qualities and, when one proves unsatisfactory in this respect, usually changes brands.

Of all the forms in which wheat has been used as human food, bread has proved the most satisfactory. It is palatable and easily served in a variety of combinations. It is well digested with very little waste. The protein content is too low for it to serve as the sole article of diet, but, eaten

with other foods, it is invaluable and well deserves its title, " the staff of life."

*Methods of Bread Making.* — In past years bread making was done almost exclusively in the home, but, like many other domestic arts, it has been largely taken over by the factory. The home has, however, only with a great deal of reluctance given up the baking of bread. Until recent years the home-baked loaf was far superior to the product of the factory. This was shown in the contempt that people had for baker's bread and in the delight that patrons of bakeries expressed when afforded an opportunity to eat home-made bread. Though now factory-made bread is usually of excellent quality, the reputation of the home-made article is still superior. The strength of this opinion is shown in the fact that practically every town and city has a bakery using the label " Home-made " or " Mother's Bread " for its product.

Although bakeshops are as old as history, for many centuries there was but little progress in them. Within recent years, however, the baking business has been revolutionized to such an extent that even the men who have been responsible for the rapid changes are still marveling at them. While some bakeries still exist in which there are few indications of progress, in the great majority of cases new and better ways are displacing the old.

*Scientific Methods of Bread Making.* — The housewife and the old-time baker recognize that a certain amount of luck enters into each baking. They cannot produce a uniform product. Modern baking is scientifically done. Nothing is left to chance. The baker has studied the principles of baking and understands the working of the laws that govern his product. In his bakery there is a laboratory where with microscopes, tubes, balances, and other instruments, the materials to be used are tested by experts. By this means baking qualities of the flour are determined and uniformity is maintained by blending flours whose contents are known. The temperature and the humidity of the mixing room are likewise controlled to such an extent that uniform conditions are maintained regardless of weather changes. Flour, yeast, salt, milk, sugar, — everything put into the vat is weighed in exact proportions. Should the flour or yeast vary or should a slightly different product be desired, the baker knows just what treatment is needed to produce the desired results. He is guided by scientific laws.

*Sanitation in Bread Making.* — The teachings and demands of modern sanitary science and the desire to cut down manufacturing expense have been factors which have acted as a spur to both machine men and bakers. Both of these causes have stimulated a demand for automatic processes

of bread making. These processes are in turn being improved each year. Now no hand need at any time come into contact with the bread. The materials are weighed, tempered exactly, put into the mixers, thoroughly combined, and forced into troughs in the fermenting room. When the dough has reached the desired lightness it is dropped out of the troughs into the divider, where it is cut into pieces of the weight desired. These pieces are then carried on a canvas belt to the *rounder*, by which they are rolled into balls. They are then conveyed into the *proofer*. This is an inclosed vat where the balls are moved slowly up and down until they recover their lightness. From the *proofer* they are carried through the *molder*, where they are given proper shape. The molder drops them into the baking pans, which are placed on racks until ready to be transferred into the ovens. After the loaves have been taken from the oven and cooled, they pass through the wrapping machine. Then they are ready for the delivery wagon.

The bread delivery wagons are familiar sights in every city and even in some rural districts. An up-to-date bread wagon has a closed box which is lined with canvas to keep out the dust. The loaves rest on trays and the whole interior is kept scrupulously clean.

The strictly modern bakery is a model of sani-

tation. Walls and floors are white and are kept free from dirt. The workmen, before beginning their tasks, are required to put on white suits supplied by the bakery. There is little opportunity for contamination of the bread. It is true that such care is not evident in every bakeshop, but

FIG. 82. — Modern method of delivering bread. The loaves are wrapped in waxed paper by machinery at the bakery.

rigid inspection is rapidly eliminating unsanitary conditions.

**The Making of Biscuits or Crackers.** — In Europe all articles of food in the shape of small sweetened or flavored cakes made from flour are called *biscuits*. Such cakes were at first unknown

in the United States, and the term generally applied to the first crude productions made of plain and unsweetened dough was *cracker*. In this country the term *cracker* has continued to be used for the plain, crisp, unflavored product. But when our crackers were introduced into

*Courtesy Loose-Wiles Biscuit Co.*

FIG. 83. — A large factory where biscuits, or crackers, are made.

Europe, they were included under the title of *biscuits* and to some extent this general classification has been adopted here. Both names are still in use.

The first cracker which was produced in the United States was the pilot or ship bread. This

was a large, clumsy, hand-made crisp loaf, which was baked on a piece of sheet iron placed on the floor of a tile oven. To-day the manufacture of biscuits is a large industry and it has reached a high rank in efficiency. Machinery has altogether taken the place of hand labor. The European sweetened cake is also produced in this country, where altogether over five hundred varieties of biscuit are manufactured. Although we have an increasing export trade with the West Indies, Central, and South America, our crackers and cakes are largely consumed at home. Attempts have been made to introduce new brands into European markets but they are soon produced in English ovens and the American trade declines. This is because of the almost prohibitory competition of foreign, cheap labor.

The manufacture of biscuits demands intelligence and business sagacity. New specialties are constantly being produced, and a host of artists are kept busy originating attractive and suitable labels and coverings for the various packages in which the goods meet the public. An afternoon tea or luncheon is not complete without some of these dainty biscuits. Ice cream parlors use them in enormous quantities. Not a picnic party plans an outing without calling on the grocer for a supply of biscuit. Every vessel that crosses the ocean carries them in its storeroom. They are used

almost everywhere as an important article in food supply.

### Questions and Exercises

1. Why do we usually think of wheat whenever reference is made to bread? From what other grains is bread made?

2. In what ways is wheat straw commonly disposed of? What manufactured articles in common use are made of wheat straw?

3. Why is wheat not generally used as stock feed, particularly in the United States?

4. Suggest reasons for the popularity of macaroni as an article of diet. Discuss methods of its manufacture in American factories.

5. Why have cereal breakfast foods come into such general favor? Generally what is true of the sanitary conditions under which they are made?

6. Make a list of the wheat foods sold in your locality and learn where each is made.

7. What is the principal use of flour? How do flours made from hard and soft wheats differ in baking qualities?

8. What is the most important use of flour made from Durum wheat?

9. Compare graham flour and the so-called whole wheat flour as to their content and uses.

10. By inquiry of grocers and flour dealers, learn what brands and grades of flour are manufactured or sold in your town. At what different prices are they sold? Try to find out why some grades sell at higher prices than others.

11. Visit, if possible, a large bakery and write the story of "The Baking of Bread." Compare methods with those used in the home.

# CHAPTER XI

## *INDUSTRIAL REVIEW*

**The History of the Wheat Plant.** — Wheat early became a cultivated plant. Its origin precedes human history. It was cultivated by the Chinese 3000 years before the birth of Christ and, according to their legends, is a direct gift from heaven. A field was plowed each year by the emperor in preparation for the planting. Thus he expressed his appreciation for the gift, and by his work he dignified labor.

The Egyptians have a legend attributing the origin of wheat to Osiris, the goddess of the Nile. A tomb at Thebes built probably about 1500 B.C. bears a painting which shows some of the early cultural methods of the Egyptians.

Wheat is often referred to in both the Old and the New Testaments. Job xxxi, 40 indicates that some of the wheat pests were known, for it reads, "Let thistles grow instead of wheat." In the third chapter of Matthew we get a hint of early threshing methods: "Whose fan is in his hand, and he will thoroughly purge his floor and gather

his wheat into the garner." These references prove that wheat was cultivated and was an important food at least among the peoples of ancient Egypt and Palestine.

The accounts of Strabo, the Greek historian, and of Lippert, a Chaldean writer, point to the valleys of the Tigris and Euphrates as the original home of wheat. The most widely accepted theory holds that there it was first domesticated. From this center it spread over western Asia, Africa, Europe, and then to the New World.

**Wheat in America.** — So far as is known, wheat was not grown in America before the discovery by Columbus. It is said that a few grains were found in some rice which was used as food by Cortez and that these were sown before 1530. Missionaries introduced wheat into California in 1769. Gosnold, in 1602, brought some wheat into the eastern part of the continent, where it was planted on the Elizabeth Islands off the southern coast of Massachusetts. Although wheat was first cultivated in Virginia in 1607, the region of its first commercial importance in North America was northern Maryland and southern Pennsylvania. Baltimore was the first great wheat-exporting city of the North American colonies.

**Motive Power in Wheat Production.** — *Man.* — Man's own energy was the only power used in cultivation for a long time. To us this seems a

low type of development. Progress was very slow and each step forward covered much time. As long as man was using his own energy as motive power, he had little left to expend for other purposes and, thus unable to invent better means, he continued to scratch the soil with sticks. Barbarous and semicivilized people are still found in various parts of the world who raise wheat in much the same manner as did prehistoric man. Among them, conditions are such that human labor is indeed the most economical.

*The Use of Animals in Raising Wheat.* — The utilization of animal power marks a great step in advance. Then with the advent of the use of oxen, camels, mules, and horses, man was relieved of much of the drudgery of farm work and was required to make higher use of his intellect.

*The Use of Steam and Gas Power in Raising Wheat.* — Next came the use of steam and gas power, forms which are now of great importance in the large wheat regions. Though they have been applied to many phases of wheat production, they are most widely used in plowing and threshing.

*Plowing.* — The most primitive plow known was merely a crooked stick that man used in loosening the soil. Some of the early plows had a piece of wood attached which projected forward so that two men could pull it. Two men likewise held the plow in the ground by means of a handle

behind. This was hard work, and the plowing was poorly done. The plow pictured on Egyptian monuments was better shaped and was tipped with iron. Long before the time of Christ, however, plows were made so that animals could be hitched to them. Plows are now of various kinds, adapted to the various types of soils as well as to the various forms of motive power. The depth of plowing also can be regulated to suit varying conditions. Thus in contrast with the old, the modern plow is a fairly complex machine.

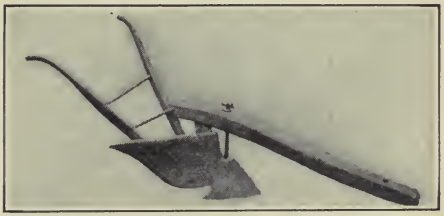


FIG. 84. — The wooden plow in use during colonial times in North America. The iron point was the most costly part.

*Sowing.* — Following nature's method of seeding, man first scattered the grain over the ground. Practice made the sower so skillful that the required amount of wheat was scattered evenly over the field. Pictures of the ancient sower clearly bring out the rhythmic tread and the swing of the arm as he threw the grain from the bag which hung from his shoulder. This method of sowing was called broadcasting, and is still followed where farms are small or where the standards of farming are low. Hand sowing was hard and tedious work. In time mechanical broadcasters came into use

and such machines are still found in operation. Where large areas are to be sown the wagon broadcaster is the most popular of these machines. With this implement over a hundred acres can be sown per day, whereas by hand one man can sow only about sixteen acres. The machine may also be regulated to sow thick or thin as may be desired. A later method of planting which developed is drilling. This has an advantage over broadcasting in that the seed is not scattered by the wind, and is planted at a uniform depth.

*Harrowing.* — Some method of leveling and pulverizing the soil has always been used as far back as we are able to trace the story of agriculture. The oldest method known was to drag a branching limb of a tree back and forth over the field. Sometimes several branches were fastened together, thus covering a wider area. This method is common even now in some countries. Later, wooden pegs were fastened into branches, making thus a crude harrow which, drawn over the fields, would comb and rake the soil to an even surface. Such harrows were used by the Romans before the Christian era. They resembled in their essentials the modern machines. Improvements have added to the effectiveness of this implement and it is now made in sections so that it will better reach uneven surfaces. Likewise in the modern implement the teeth are so adjusted by means of

a lever that they may be set at the proper angle for best results.

*Harvesting.* — Means of gathering the crop seem to have presented the greatest difficulty, and very radical changes have taken place even within recent times. The fundamental principles involved in the other machinery were applied in the most ancient times. Harvesting methods remained crude and inadequate through all the early centuries.

*The Sickle.* — While the first method of gathering grain was probably by pulling it up and breaking off the heads either by hand or with a crude comb, the use of simple machinery began early. Sickles of bronze and iron have been found among ancient ruins in Europe. Egyptian harvest methods in use long before the Christian era are represented in their ancient paintings. There sickle-like implements were used, and the grain was either cut just below the heads or was cut low down and bound into sheaves. Ancient Chinese, Japanese, Greeks, and Romans also used sickles. The earliest form of sickle seems to have consisted of a slightly curved blade of iron or bronze fastened at one end to a straight handle. Soon the blade became serrated, strengthened, and more curved. The sickle also became lighter. A man cut on an average about an acre a day. Usually the grain was gathered into sheaves and

bound with a handful of straw. Even though the sickle was one of the earliest instruments, it is still used in small fields in Palestine, China, Spain, and other places.

*The Cradle.* — Another ancient reaping instrument was the cradle. It was operated with both hands and carried a framework to collect the grain as it was cut. Americans perfected the cradle; and, in the perfected form, the cradle rapidly replaced the sickle. It seems strange that so simple an implement and one used in prehistoric times should not sooner have reached a perfected form. For thousands of years the sickle and the crude cradle had been practically the only harvesting implements used in the wheat harvest. The American cradle came into use during the Revolutionary War. It marked the beginning of inventions which have led to the complicated machinery of to-day.

*The Header.* — Ancient writings give an account of a crude harvesting machine which was used in Gaul about 70 A.D. According to Pliny's description this was a header. It consisted of a box mounted on two wheels. In front of the box was a set of teeth made of sticks and set close together. An ox yoked to the rear moved this implement through the field. The teeth tore off the heads of the wheat, which a man then raked into the box.

This machine fell into disuse and was forgotten for many centuries, but its history seems to have served as the basis for the first English inventions. An early English header was planned by William Pitt, and constructed about 1786. It had a revolving cylinder set with teeth by means of which the heads of wheat were caught and carried over

*Courtesy International Harvester Co.*

FIG. 85. — The first reaper.

into a box at the rear. This was the first of a series of machines which led to the perfection of the modern header sixty-three years later.

*The Reaper.* — In the meantime a set of machines built along different lines was invented. These machines were called reapers. The first reapers made by the English had not proved very successful, when, in 1803, American machines began to appear. These soon became the leading

reapers both in the United States and in Europe. Although they are seldom used now in harvesting the grain in the United States, the American reapers are still the best on the market. Reapers, when the grain is cut, leave it about the field in loose bunches. This grain must then be bound

FIG. 86. — Modern harvesting methods. Some-

into sheaves by hand. In the United States, labor was scarce and large land areas favored extensive cultivation. Because of this condition, the demand for a binding attachment in connection with the reaping machines became urgent and served to stimulate invention. These inventions

have resulted in the present self-binding harvester, an American product. It is really a combination of the good points of all other types of machines with a binding device added.

*The Self-binder.* — The story of the struggle to make the machine bind the grain is a very inter-

times several binders are pulled by one tractor.

esting one. The first attempts were made about 1850, but the efforts were not rewarded with success until more than twenty years later. The process looks so easy now. We watch the binder collect a bunch of grain, encircle it with twine, tie the knot, cut the twine, and drop the bundle; and we

are apt to lose sight of the fact that hundreds of attempts to solve this problem were made before success came.

We have seen that the credit for working out the foundation principles of harvesting machinery belongs to English inventors. American genius, however, improved and perfected the machines and thus made them practical. The English originated the idea, but the Americans brought about the real development of harvesting machinery. American harvesting machines are the most nearly perfect in the world and are being used in all wheat countries.

*Threshing the Grain.* — In threshing, no doubt, the first grain was shelled out by hand. There are, however, records of many other primitive ways of securing the wheat. Probably one of the first was to pound the grain out with the sticks or to beat the sheaf upon the ground. As production increased, these methods became too tedious. The ancient Egyptians spread the loosened sheaves on a circular inclosure of hard ground from fifty to one hundred feet in diameter and drove animals round and round over it so as to tread out the grain. This inclosure was usually an elevated piece of ground so that the wind could be utilized in clearing away the chaff. Since such a method was injurious to the grain, the threshing sledge gradually took the place of treading. This device

was either a platform with a grooved bottom or a heavy spiked roller which was drawn over the threshing floor by oxen. The Greeks likewise used the sledge and it is even yet doing service in some countries. A crude thresher now used in Italy appears to be a descendant of the sledge. It is a tapering roller fastened to an upright pole located at the center of the threshing floor and pulled around at the outer end by oxen. Both of these methods have been used in the United States.

Horses were used in early times to tramp out the grain, and sledges were found as late as 1830. The flail, which was in common use as late as 1860, probably grew out of the early method of beating with sticks. It consisted of two shaped sticks fastened together at one end with stout thongs. One stick was the handle, the other the beater. In 1732 a Scotchman worked out what was then considered a wonderful invention. He united a large number of flails which were driven by water power. All the early machines following this were produced by the Scotch, and they really furnish the principles of the modern thresher.

The first threshing machines merely shelled out the grain. Improvements which involved years of experimental study were gradually added. Fully five to ten per cent of the grain was lost in these hand methods of threshing and the first machines

did no better. The modern machine catches practically all of the grain. A cleansing device was an early addition to the thresher by which all straw and chaff was removed in the one process. Other improvements reduced the noise and lessened the power necessary to run them. Then came the self-feeder, the band cutter, and the straw stacker. These attachments not only reduced the number

FIG. 87. — The new method of threshing — the combine.

of men needed but saved time and added to the efficiency of the work. Threshing machines began to come into common use in England about 1820 and were widely used in the United States in 1835. At first the threshers were run by water power or by wind. Later horse power became common. It was not until about 1876, however, that steam began to come into use. Practically all the

threshing in large wheat areas is now done by steam or gas power.

**The Development of the Wheat Industry.** — The extensive fields of the New World served as the direct incentives for the invention of wheat-producing machinery. Population was small; labor, scarce; and opportunities for production were great. Mechanical means for assisting human labor were necessary and so inventive genius responded. Modern machinery is the result. In other new fields machinery likewise made production profitable, so that the wheat-raising industry led to rapid settlement of Australia and Argentina. The Old World found that machinery could do much to increase the amount of production and lower the cost. Thus modern methods are characteristic of every great wheat country. These methods must of course vary with local conditions.

It is interesting in this respect to learn how the different nations take their places in the production and utilization of the world's wheat crop.

### Questions and Exercises

1. Suggest reasons why the Chinese regard wheat as a direct gift from Heaven.

2. How do the legends of the origin of wheat show similarity in recognizing its qualities?

3. Account for the fact that wheat was one of the first

grains planted by the Virginia colonists. Where was the seed wheat grown?

4. Why was improvement in methods of tillage very slow as long as man did all his work by hand?

5. Contrast the primitive methods of plowing with the modern.

6. How are seeds planted by nature? How has man improved nature's method of planting wheat?

7. What were the primitive harvest implements?

8. Give a brief résumé of threshing operations showing development of methods from ancient to modern.

9. Explain how the large fields of the New World served as incentives to progress in wheat production methods.

10. How did the increasing population of European and American countries serve to stimulate inventions?

11. Explain how improved methods of production have affected the settlement and development of new wheat lands.

## CHAPTER XII

## *THE WHEAT COUNTRIES*

Now that we have studied wheat, its form, the manner of its growth, and its uses, we are ready to learn what it means to the life of different peoples. It is of interest to know where wheat is grown, to what extent, and why. So we are to study briefly those countries that rank high in the production of this crop, for the purpose of learning how wheat contributes to their prosperity and how it affects other countries by entering into the markets of the world. Although wheat is grown to some extent in nearly every country, our study must necessarily be confined to the countries where wheat is of considerable commercial importance. By this is meant either the countries which produce much wheat to sell or those which buy from other countries and so are important as markets for wheat. For illustration, Greece, China, and Brazil produce wheat, and they also buy some wheat and flour, but since in those countries the wheat trade is not very important, we omit them from our list.

The various wheat regions have different con-

FIG. 88. — Map of Australia.

ditions of soils, climates, and peoples, hence methods of producing and handling the crop are greatly varied. Since the discussion of wheat production has been based largely on the methods practiced in our own country, the contrast will be more vivid if we begin with the wheat regions which are far from the United States. For our first studies we have selected the countries of the southern hemisphere. These will be followed by those of North America, Asia, and Europe in the order named.

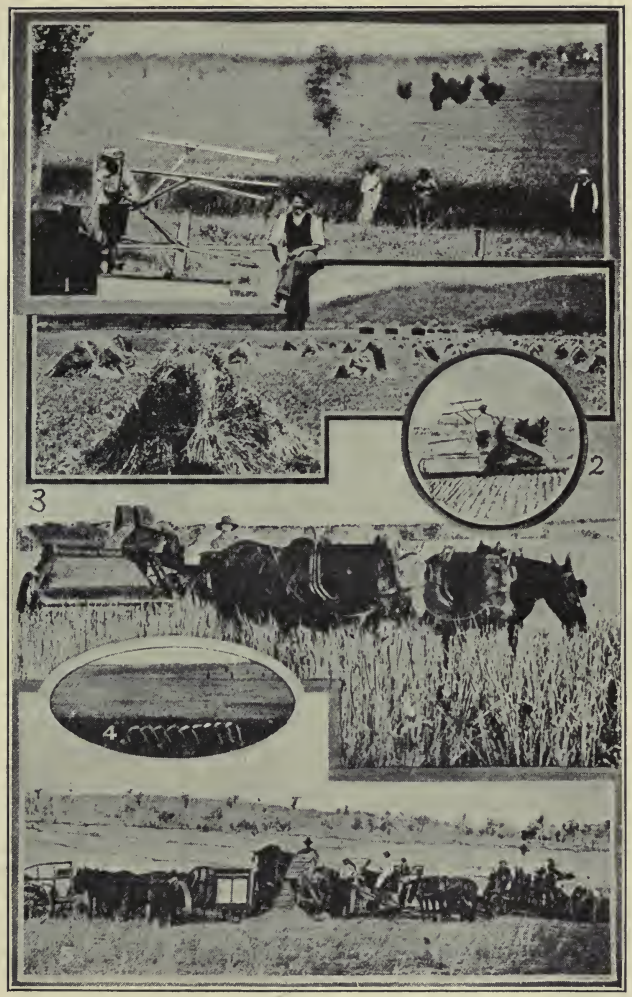
## WHEAT IN AUSTRALIA

**Australia.** — *Location and Extent.* — In a position on the globe almost directly opposite that of the United States, lies Australia, which may be called either the largest island or the smallest continent. Until commerce became important, it was almost completely isolated from all other lands. Its native plant and animal life is characterized by forms which are found on no other continent. Its geographical position is stated as latitude 10° 39′ to 39° 11′ south and longitude 113° to 135° east. Its approximate length, east and west, is 2200 miles and its breadth, north and south, 1300 miles. Although it has an area nearly equal to that of the United States proper, its population is only one eighteenth as great. Its importance in the wheat industry is

shown by the fact that it generally exports nearly three fourths as much wheat as does the United States.

*The Location of the Wheat-producing Area.* — The wheat-producing regions are confined at present almost entirely to the southeastern and southwestern parts of the continent. Of the two, the southeastern district is by far the more important. Some wheat is raised in the interior under irrigation, but its quantity is not great. Still, in spite of the localized areas, wheat is the most important crop grown in Australia. This is shown by the fact that of the arable land about 63 per cent is at present planted to that crop, while there is but 17 per cent in hay, 6 per cent in oats, and 14 per cent in other crops.

*The Climate of the Wheat-producing Area.* — The climate is the chief factor which controls wheat production. The northern and eastern parts of the continent lie in the region of the southeast trade winds. These winds bring moisture to the eastern portion. To the westward there is a range of mountains called the Australian Alps whose altitude is so great that it serves to condense the moisture on the east slopes and highlands and leaves the western slopes dry. Since the western plateaus are not high enough to cause condensation of moisture to any great extent, these conditions produce a very dry, desert-like interior of




*Courtesy Dept. of Agriculture, New South Wales.*

FIG. 89. — Harvesting methods in Australia: *1* and *2*, use of the binder; *3*, the stripper-harvester, strips heads from stalks; *4*, wheat in sacks; *5*, threshing.

the continent. This interior region is often called the Dead Heart of Australia. The monsoons bring some moisture to the northern coast region as do the west winds to the southwest coast. Winter is the season of most abundant rainfall in the southwestern part of the country, and for

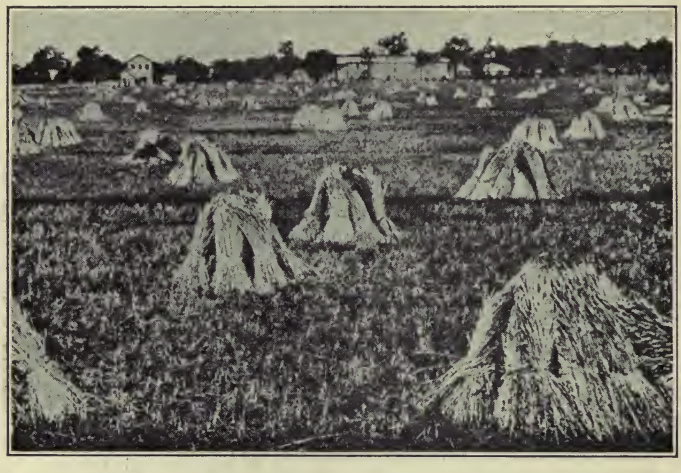


FIG. 90. — Wheat in shock in New South Wales. Shocks there are generally called stooks.

the southeast districts a large part of the rainfall occurs in the spring. In considering Australia, it must be remembered that the seasons there are the reverse of those in the United States. Our winters occur during their summers. The temperature is generally warm. The lowlands in the southern part of the country are never cold, and the northern part is of course tropical.

*The Methods of Cultivation.* — The chief reason for the extensive growth of wheat in this country is that it will yield fairly well even with an annual rainfall as low as 18 or 20 inches. This leads also to extensive rather than to intensive farming. Fields are large, and population low. The acreage per capita is about four times that of the United States.

Wheat growing in Australia must contend not

FIG. 91. — Hauling bundles to stack.

only with uncertain rainfall but also with insect pests and rusts. The latter are very active and live through the winter on the seed wheat. Scarcity of labor at harvest time is another difficulty, this being especially true in seasons of heavy yields.

*The Use of Machinery.* — The work is done almost entirely by machinery. Plowing and seeding are done in very much the same manner as in the United States. In many districts the harvesting

is performed by huge machines which cut or strip and thresh at once. These are drawn by engines in which straw, because of its cheapness, is usually used for fuel. One of the first stripper-threshers was an Australian invention. These machines strip the heads from the plants and leave the straw standing in the field. Such methods of reaping require the wheat to be dry, ripe, and fairly clean of weeds. Both the colonial and

FIG. 92. — Stacking wheat in Australia.

English home governments have offered bounties and prizes in order to encourage thorough and progressive methods of labor. The harvest season lasts from December to January.

*The Production of Wheat in Australia.* — Australia produces about the same yield per acre as the United States, the general average being from 12 to 15 bushels per acre. The yield, which depends on the seasons, fluctuates very much from year to year. The total production in 1911 was 98,109,000

bushels, but dropped to 73,894,000 in 1912.[1] This fluctuation is not unusual in amount. Generally speaking, the total production of Australia is about the same as that of Kansas. White wheat is used almost universally as seed, and the varieties of commercial importance have all been introduced from foreign lands. The grain is of a bright, clear color, of even texture, is rich in gluten, and is of fine milling quality.

*Production of Wheat, 1913*

| State | Acreage | Total Crop | Yield per Acre |
|---|---|---|---|
| Queensland | 125,000 | 2,038,000 bu. | 16.2 bu. |
| New South Wales | 2,231,000 | 33,499,000 " | 15.0 " |
| Victoria | 2,085,000 | 27,050,000 " | 12.9 " |
| South Australia | 2,080,000 | 22,174,000 " | 10.6 " |
| Western Australia | 793,000 | 9,457,000 " | 11.9 " |
| Tasmania | 25,000 | 650,000 " | 26.0 " |
| Total Australia | 7,339,000 | 94,868,000 " | 12.9 " |

**The Transportation of Wheat.** — *Roads and Railroads.* — Transportation facilities are still inadequate. Since there is but one partly navigable stream on the whole continent, chief dependence must be placed on roads, many of which the state builds and maintains with convict labor. The

[1] Year Book of U. S. Dept. of Agriculture, 1913.

railways are also owned largely by the states. Unfortunately, however, the various states have different gauge roads, a fact which causes reloading at state lines.

**The Exportation of Wheat.** — Although her total production is not much greater than that of one of the largest wheat-producing states of our own

FIG. 93. — Characteristic wheat stacks in Australia.

country, Australia exports large quantities of wheat. This is because of her small population. The exports in 1911 amounted to over 63,319,000 bushels. The amount which was exported by the United States in the same year was 83,330,000 bushels. The principal export centers are Melbourne and Sydney. The latter city is the terminal for many steamship lines. Most of the export trade is to Great Britain and to British colonies,

especially those of South Africa. This has become especially true in recent years because of the enactment of tariff laws which make this mutual trade very advantageous. The raw wheat is exchanged in the mother country for manufactured articles which are needed in Australia.

### Questions and Exercises

1. Where is Australia located in comparison with the United States? How large is it? Of what country is it a colony?

2. Explain how the climate of Australia limits wheat raising to certain portions of the continent.

3. Suggest reasons why large wheat fields predominate.

4. What are the chief problems of successful wheat production which the Australian farmer must meet?

5. How does the English government encourage Australian agriculture?

6. Why is England vitally interested in promoting wheat growing in Australia?

7. What is true of the quality of Australian wheat?

8. Why is the average yield per acre not very high?

9. Why can Australia export a large per cent of the wheat she produces?

10. What countries and colonies serve as the principal markets for Australian wheat? Explain the advantages of this marketing situation.

FIG. 94. — Map of Argentina.

# CHAPTER XIII

## *WHEAT IN ARGENTINA*

**Position and Extent of the Country.** — The Argentine Republic is the greatest wheat-producing country in the southern hemisphere. Although we may remember its location fairly well from previous study, it will help us to look up its latitude and longitude position in some geography textbook. We shall then note that its north and south extent is greater than that of the United States. We shall note also that it is situated nearly as far south of the equator as the United States is north. Because of this position, the seasons there, as in Australia, are the reverse of those in our own country. It has an area of 1,139,979 square miles. This is more than one third the area of the United States proper. With its population of 7,080,000 (1912) it thus averages only 6.2 inhabitants per square mile.

**The Location of the Wheat-producing Area.** — The region of most successful wheat production is to the west of Buenos Aires. It extends as far north as latitude 30°, and on the south the limit has not yet been reached. The greater part of the wheat

is, however, raised between parallels 30° and 40° south latitude. Prior to 1877 not enough wheat was grown to supply home needs, but since that time Argentina has been regularly an exporting country. In 1912 the wheat area was 17,089,000 acres, and even then it is estimated that only twenty per cent of the possible area for wheat was used. Wheat growing is moving southward and westward. With increased population and the building of new railroads, the wheat-growing region is rapidly being extended, so that within a few years the acreage promises to be doubled.

*The Topography of the Area.* — The wheat-growing region is a vast plain. It is broken by few hills, and slopes from the Andes and other lofty mountains in the west and north gradually toward the Atlantic. The soil is for the most part fairly deep, is quite fertile, open, and favorable to natural drainage.

*The Climate of the Area.* — The climate is such that the soil can be tilled at almost any time of the year. Unless it is a cold, dry winter and the pastures become bare, the farmer is able to work his animals throughout the winter with very little dry feed. In the wheat region the yearly rainfall varies from 9 to 48 inches. If a wet summer is followed by a warm, open winter, the wheat is likely to suffer from the resulting heavy growth of weeds. When there is rain during the warm winter,

this condition is made much worse. Cold fogs and frosts which occasionally come late in the spring also cause serious losses to wheat growers. The summers, likewise, sometimes become exceedingly hot, a case in which plants must be very strong and healthy and be well rooted if they are

FIG. 95. — Fifty harvesting machines going into the wheat field from a small town in Argentina.

to produce crops. Since the winds are not usually severe, this menace is not great. Droughts, however, in many sections of the country often work great damage.

**The Kinds of Wheat grown in Argentina.** — The wheat-growing region may, on the basis of

kind of wheat produced, be classified into three main divisions: the hard Durum, the semi-soft, and the semi-hard wheat districts.

*The Durum Wheat.* — The hard Durum, or macaroni wheat, district is the northernmost division, lying approximately between parallels 29° and 32° south latitude. There, the general dryness of the air, the warm temperature, and the sandy soil favor wheat of this kind. The district is not large and the wheat produced is almost all used for home consumption in the form of macaroni and similar foods. North of this district wheat production has not been found profitable.

*The Semi-Soft Wheat.* — The semi-soft wheat district, which is by far of greatest importance now, lies in central Argentina, between parallels 32° and 38° south latitude. This is the region nearest Buenos Aires; and, for this reason, marketing conditions have been more favorable than for the newer sections to the south. The common bread wheats are here grown. Of these there are numerous varieties, among which the Barletta, Russian, Hungarian, and French are the best known. The Barletta wheat is especially worthy of note, for it has proved to be the most popular. It resembles the Turkey Red of Kansas and Nebraska, although it is not so hard. It was originally introduced from Italy and has proved

well adapted to Argentine conditions. The grain is smooth, fat, dark colored, and keeps well in shipment, a quality very desirable in export wheats. It is grown to some extent in all the regions, but its quality varies somewhat with the soil and climatic conditions under which it is grown. The Barletta wheat which is raised near Buenos Aires is not as hard, and not of as good milling quality, as the same variety is when grown farther south. Another valuable feature of Barletta wheat is its ability to stand long after it is ripe without shelling out. Since labor is often scarce in Argentina and the harvest is necessarily prolonged, a wheat that can stand delay is in demand. Barletta also resists climatic hardships such as frost, drought, and heat, and is less likely to be damaged by rusts than are some other varieties. Russian wheat has also proved successful, especially in the south, although since its resistance to shelling is not strong, it must be harvested promptly when it is ripe.

*The Semi-Hard Wheat.* — The semi-hard wheat district lies to the south, at this time from latitude 38° to 42° south. This area, which was formerly not thought to be wheat country, has been proved by recent results to be well adapted to this crop, and so the boundaries of the region are now being pushed still farther southward. The climate corresponds to that of the hard winter wheat section

of the United States. The rainfall is low, varying from 10 to 20 inches per annum. In some cases irrigation is practiced and dry farming methods are also employed. The largest yields in any part of Argentina have been reported from the territory of Chubut, 700 miles south of Buenos Aires. The wheats grown there are of the same varieties as those grown farther north, but because of the coolness of the climate and the moderate rainfall, the yields are higher and the qualities are better. It is also true that the farther from the equator wheat is grown the more quickly does it mature. This is due to the fact that it has longer intervals of sunlight just when light has the most effective influence. Barletta wheat grown in Chubut sometimes weighs sixty-six pounds to the bushel. The development of this area has been slow. This is because there is a large area to the north which has seemed more attractive because of being nearer the export centers and well served by railroads.

**The Methods of Cultivation.** — *Plowing.* — The plowing is done with riding and walking plows which are very similar to those used in the United States. In much of the country single walking plows drawn by oxen are used. Usually from two to two and one half acres are plowed per day. The work is done in this leisurely way because the land can be plowed at almost any time during the year. Experience has shown that, after the first

one or two years, the land should be plowed twice for each crop in order to get the best results. The first plowing should be 8 or 9 inches deep immediately after the removal of the previous crop. This would be from February to April. The second plowing should be shallow, 3 or 4 inches, and should be done just before sowing, which would be from May to August.

While the foregoing method is the one that should be used, more than one half the wheat is planted on land that has been plowed but once just before planting. The plowing is usually from 3 to 4 inches deep and is also badly done. The furrows are crooked, are of uneven depth and width, and look as if they had been made with a primitive wooden plow. The field looks as though an ordinary corn cultivator had been run through it rather than that it had been plowed for planting. Deep plowing has been followed in Chubut by a colony of Welsh farmers, and the largest yields of the best wheat have there been secured.

*Methods of Seeding.* — Most of the seeding is done by broadcast seeders or by hand. The seed is covered by harrowing, and often the work is poorly done. Only about one eighth of the sowing is done by drills. The amount of seed wheat used per acre varies from three fourths of a bushel to one and one half bushels. The time of seeding varies with the latitude of the region. It begins

north of Buenos Aires, about May 15, and it ends in Chubut in August.

*Harvesting the Wheat.* — Harvesting begins about the middle of November in the north and progresses southward, so that the wheat is all harvested by about January 15. Ordinarily 80 per cent of the crop is harvested in December. Most of the

FIG. 96. — Threshing wheat on a large wheat farm in Argentina.

wheat is cut with binders, is shocked, and stacked much as it is done in the United States. The stacks are often poorly built and thus permit rain to soak in and damage the grain. Headers are extensively used for cutting the wheat in the northern section.

*Threshing the Grain.* — Threshing begins soon after the stacking and continues until March.

Steam power threshing outfits, imported both from the United States and Great Britain, are used. It is conceded that threshers manufactured in the United States do the best work, but the objection is made that they require skilled mechanics to operate them. Hence the British machines, being much simpler though less efficient and

Fig. 97. — Wheat awaiting shipment, Argentina.

costlier, are preferred. The farmers of Argentina are largely south Europeans and many of them do not have the ability to handle machinery that characterizes the north Europeans, who constitute the wheat farming class of the United States.

The cost of harvesting wheat is from 9 to 11 cents per bushel. This does not include the expense of sacks, which is quite an item, since the

grain is all sacked and hauled directly from field to market. Because of this method there is likewise no farm storage in granaries.

The chief difficulty with the harvest in Argentina is the lack of sufficient help. Fields are large, labor scarce, and wages high. The farmer who has planted more than he and his family can care for finds it a difficult task to save his crop.

**The Production of Wheat in Argentina.** — Wheat production in Argentina has shown a general steady increase since 1870. In 1912 the total crop amounted to 198,000,000 bushels.[1] The yield varies from 10 to 38 bushels per acre, the low yields generally occurring in the northern districts, the high yields in the southern. The cost of production has been estimated to be from $7 to $10 per acre, which would make 50 to 60 cents per bushel. It is interesting to make comparisons with our own states or localities in the matter of yield and cost of production.

**The Exportation of Wheat.** — Exports, which began in a small way in 1878, have increased steadily and so rapidly that Argentina now ranks as one of the greatest wheat-exporting countries in the world. She is favored by having vast areas of easily tillable and highly productive land which is suitable for wheat. Her position on the Atlantic seaboard gives her easy access by water

[1] "Argentine Republic," Pan-American Union, August, 1913.

route to the great European market centers, Bordeaux, Havre, Liverpool, and Hamburg. Much wheat is also sold to Brazil through the ports of Bahia and Pernambuco.

Absence of navigable streams extending into the interior, however, necessitates extensive rail-

FIG. 98. — Docks and elevators, Buenos Aires. Export facilities are excellent.

way systems. While improvement along this line has been rapid, much of the country still feels the need of railroad development. Along such railroads as exist, shipping facilities are poor, warehouses are few, and as a result much wheat awaiting shipment is stored in piles along the tracks. The government is now attempting to remedy this

condition by compelling the railroads to build suitable warehouses. This does not entirely remedy matters, for even where warehouses are built, they are often not used because the Italian farmers refuse to pay the storage charges. Terminal facilities are good. Large wheat elevators of the most modern type have recently been built at Buenos Aires.

Considerable milling is done in the larger cities and some flour is exported. On the whole, however, it is not the flour, but the wheat from Argentina, that enters into the commerce of the world. Its quantity, 96,000,000 bushels exported in 1912, makes it a strong factor in determining market prices.

**The Development of the Wheat Industry in Argentina.** — Argentina needs capable agriculturalists with some capital who will improve farming conditions. Half of the farmers now raising wheat there have no intelligent idea of how it should be done. The government is taking steps to assist in the improvement of agricultural conditions by organizing schools and establishing experiment stations. It is now generally agreed that Argentina has a promising future, though it will come through a slow laborious evolution rather than by a sudden development. This condition could not be otherwise because of the character of the population out of which agricultural progress must be worked.

### Questions and Exercises

1. Contrast the location of Argentina with that of the United States.

2. In what part of Argentina is the region of most successful wheat production?

3. Briefly describe the climatic advantages and disadvantages of Argentina.

4. In what parts of Argentina is Durum wheat most extensively grown? Why?

5. What qualities serve to make Barletta wheat very popular in Argentina?

6. What is the leading wheat harvest month of Argentina? State why the harvest season occurs then.

7. How does the type of farming population affect the threshing methods?

8. When did Argentina become inportant as an exporter of wheat?

9. What countries serve as the principal markets for Argentine wheat?

10. What is the attitude of the government of Argentina towards agriculture? What effect will this have on the future wheat production?

## CHAPTER XIV

## *WHEAT IN THE UNITED STATES*

Among all the countries of the world, the term "*first in wheat*" is one which may be correctly applied to the United States. While Russia sometimes excels her in amount produced, this country can still claim first honors because of steady production and high quality, and because wheat is the principal breadstuff for all the American people. Although its relative importance varies widely in different sections of the country, wheat is raised in almost every state in the Union. Since conditions are so diverse, it is first necessary, in order that the wheat situation may be viewed fairly, to study the different wheat regions separately. The dividing of the country into these regions also becomes a problem, since any basis of classification must include soil, topography, climate, and the kinds of wheat produced. Furthermore, because of the variation in all these factors there is likely to be difference of opinion concerning where to draw the division lines. The following regions, however, may be suggested: north-

FIG. 99. — Map of the United States.

east, southeast, northeast central plains, northwest central plains, southwest central plains, western valleys and plains.

**Wheat Production in the Northeast Region of the United States.** — This region includes the New England and the Middle Atlantic states. Only spring wheat is raised in the former. In general it may be said that neither New England soil nor climate is very favorable to wheat production. The summers are short, moist, and cool; the winters, long and severe. The balance of the region, however, is important as a winter wheat producer, this being especially true of New York, Pennsylvania, and Maryland. There the soil is generally more favorable, the summers warmer and longer, and the winters less severe.

The rainfall of the region is high, from 40 to 50 inches annually, and is fairly well distributed. The percentage of sunshiny days is here not so high as it is in the interior states, and the harvest season not so free from rain. Largely because of these climatic conditions, soft wheats are grown.

*Methods of Cultivation.* — Throughout much of the region the land is hilly, and the fields are small. This condition accounts for the fact that much of the plowing is done with walking plows, pulled by two or three horses. The autumn is the plowing season. For winter wheat, the ground is harrowed soon after plowing, but for spring wheat that

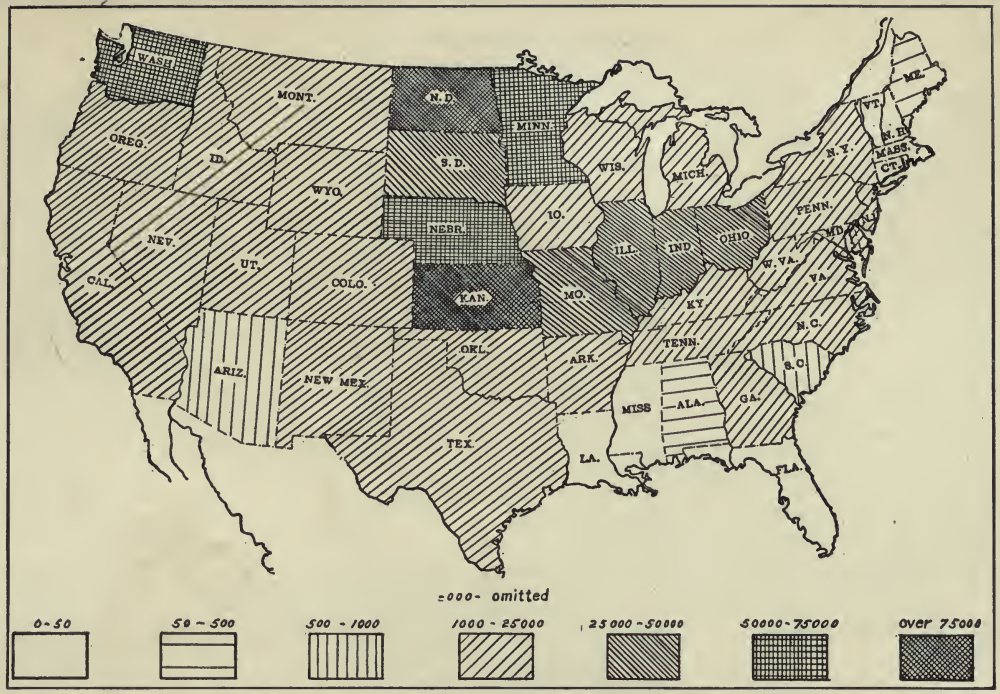



FIG. 100. — Production of wheat in the United States expressed in bushels.

operation is deferred until just before the spring sowing. The sowing, where land is rough, is done by hand. Under other conditions small drills are used. Because of the late autumns, winter wheat is sown in September, or even as late as October.

FIG. 101. — A wheat field in New York. Note that only two horses are used to pull the binder. In general, small sized machinery is used where fields are not large.

Spring wheat is sown as soon as the frost leaves the ground, usually in March or early April.

*Harvesting the Wheat Crop.* — The harvesting of winter wheat begins early in July ; of spring wheat, about a month later. Self-binders are generally used, those with the six-foot cut being the most common. In some of the very hilly sections, where steep slopes prevent the use of reapers and binders,

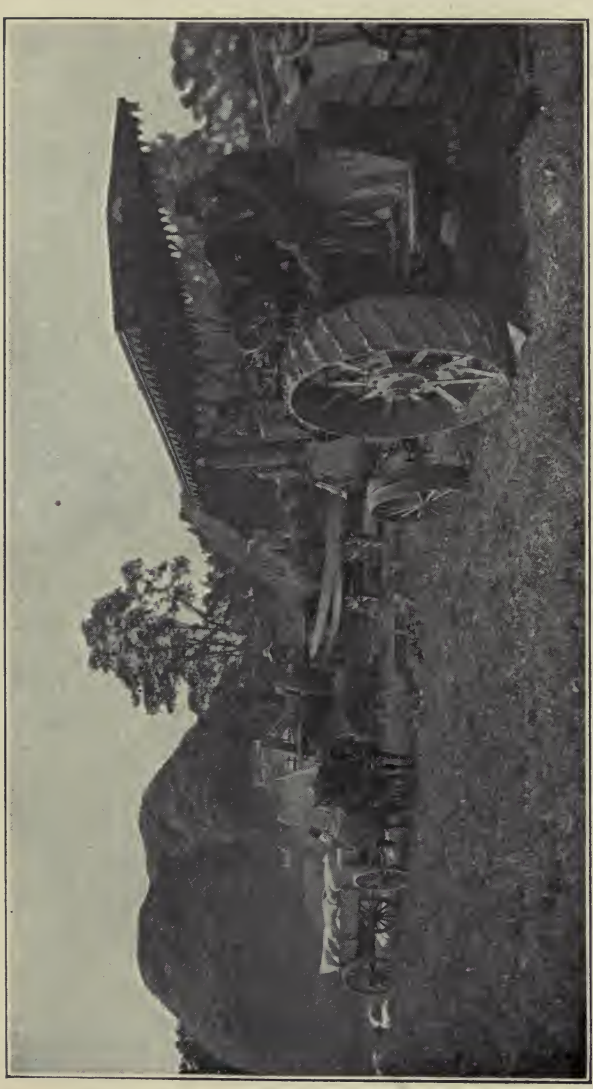


FIG. 102. — Threshing out of stack in New York. Observe that the wheat is handled in sacks.

the cradle is, however, still the prevalent harvesting machine. Where these conditions prevail the fields are small and the wheat produced forms but a small part of the total production.

The threshing is usually done with small machines operated by six to twelve horse power engines and, since much of the grain is stacked, it usually continues until late in the autumn.

*The Wheat Supply and Demand in This Region.*— In the geography of wheat, this region, which embraces the most densely populated part of the United States, is more important as a consumer than as a producer. Its production is only about $5\frac{1}{2}$ per cent of the total for the United States. Thus with its dense population this region in wheat production falls far below the amount adequate for its needs. This condition exists in spite of the fact that we here find intelligent, intensive farming, the extensive use of fertilizers, and a very high average yield per acre. Maine in 1913 reported an average yield of spring wheat of 25.5 bushels per acre, and the winter wheat in Pennsylvania for the same year averaged 17 bushels per acre.

Very little of this wheat is exported. It is mixed with western wheat and used for milling purposes. Prices received for it are higher than those received for wheat in the western regions. The farm price per bushel in New York state is

generally from 20 to 25 per cent higher than in Nebraska or Kansas. This difference in price is not due to a difference in quality, but to the facts that markets are nearer and that there is a shortage in local supply, and it must be borne in mind that the cost of production is also higher in this region. This higher production cost is caused by the careful methods of tillage and use of commercial fertilizers.

**The Southeast Wheat Region of the United States.** — All the states south of the Potomac and Ohio and east of the Mississippi are grouped together in this region. Notwithstanding the fact that there are within this region strong differences in soil and topography, there is a general similarity in climate and in the kinds of wheat raised. Winters are mild, and summers are not excessively hot. The rainfall is heavy, averaging from 40 to 60 inches per year, and the humidity is high.

The soils vary from sandy to very heavy clay, and they are generally lacking in some of the constituents necessary for wheat. Commercial fertilizers are therefore used in every state. In some places they are used in large quantities. The cost of these commercial fertilizers averages from one to three dollars per acre.

*The Methods of Cultivation.* — Winter wheats are grown exclusively, and of these all the varieties raised are either of the soft or semi-hard types.

The fields here are generally larger than those of the northeastern region, but are small compared with those of the West. Ten to forty acre fields are common. In the preparation of the soil both walking and riding plows are used. Among the latter type there is practically no usage

FIG. 103. — A typical wheat scene in the Shenandoa

of the gang plow. The harrows vary from small one-horse affairs to the eighteen-foot size which are drawn by three to five horses. The small sizes are the more common. Sowing, which takes place between late September and early November, is done by broadcast seeder or drill.

*Harvesting the Wheat Crop.* — June is the harvest month for the wheat of this region. The self-

binder is the most generally used machine, although in the hilly sections places are found where the wheat is cut by reaper, mower, or even by cradle. Small threshing machines are the rule, and the threshing takes place both out of shock and stack. The latter is probably the more common method.

alley, Virginia. Blue Ridge in the background.

*The Wheat Supply and Demand in This Region.* —This region ranks low in production, only 5.7 per cent of the 1913 crop in the United States being credited to the ten states. Virginia, Kentucky, and Tennessee rank highest, Florida and Mississippi lowest. Here, as in the northeast, the yields are not high, ten to fourteen bushels per acre being the average, and not enough wheat

is raised to supply the local needs. This is in part due to adverse soil and climatic conditions. The yield, however, could undoubtedly be increased were more improved methods of farming employed. Most of the wheat is cared for by the local markets, and the greater part of it is milled near the place of production. Market conditions are good. The

*Courtesy Norfolk and Western Railway.*

FIG. 104. — Harvest scene in the Great Valley of southern Virginia, near Roanoke.

price of wheat is higher in this section than anywhere else in the United States. The price per bushel received by the farmers is from 25 to 50 per cent higher than that received by the wheat farmers of Kansas and Montana, and is generally considerably above the prices paid even in the northeastern states. In 1913 the wheat farmer of

North Carolina received 13 cents per bushel more for his product than did the farmers in New York. The explanation for this price condition is that this is an importing region, and is not favorably located to receive the wheat sent out by the wheat regions of the West. The facts that the local demand exceeds the supply and that location conditions make wheat importation costly necessarily result in high prices. One of the importation difficulties becomes apparent when we realize that the great export routes of the interior pass north of this section and directly through the northeastern states. Importation in that section is thus rendered easy and consequently lower prices result.

The high wheat prices, however, of the Southeast are serving to increase the amount of production. The region has many advantages and its difficulties can be largely overcome. The future will probably see a moderate increase in its importance as a wheat producer.

**The Northeast Central Plains Wheat Region.** — This region comprises the states north of the Ohio and east of the Mississippi rivers. Considering the extent of the area, its unity as a wheat-producing region is marked. The soil is nearly all of glacial origin and varies from light sandy to heavy clay. The greater part of it is a sandy loam free from bowlders. Since the fertility is high, commercial fertilizers are not used to any great

extent except in the older settled parts of Ohio and Indiana. The topography is gently rolling, and most of the land is well drained. The rainfall varies from 30 to 40 inches and is in ample quantity during the growing season. The summers are warm; the winters, moderately severe. The growing season likewise is long enough for any of the common wheat varieties.

FIG. 105. — Extensive wheat fields on the gently rolling glacial drift plains. Typical of Iowa, northern Missouri, and eastern Nebraska.

*The Methods of Cultivation.* — Semi-hard winter wheat is the type most generally raised throughout the whole region, though in places there is some spring wheat grown. In Wisconsin, winter and spring wheat are raised in about equal amounts.

The Northeast Central Plains region is one of diversified agriculture and the farms are much

larger than are the fields which are given to any particular kind of crop. Fields are generally of moderate size. The area of the common wheat field is usually not more than from 40 to 80 acres. Such plows and harrows are purchased as may also be used to advantage in producing other small grains and corn.

FIG. 106. — Plowing for wheat on the loess plains of Nebraska.

Plowing, if for spring wheat, is done late in the autumn or early in the spring; if for winter wheat, the favored season is early, even as early as July. The two-bottom gang or the single-bottom sulky is the type of plow used. The former is becoming very widely used because it is a size well adapted to the fields of this region.

The ground is harrowed immediately before

sowing. This is usually done by means of three-section steel harrows which cover a width of from fifteen to eighteen feet.

The winter wheat is usually sown in September or October; the spring wheat as early as possible, March being the favorite month. Sowing is generally accomplished by means of an eight to twelve hole press drill, although in heavy soils broadcast seeding is often practiced. In either case from a bushel to a bushel and a half is the amount of seed wheat sown per acre.

*Harvesting the Wheat Crop.* — The principal harvest month is July. In the southern part of the region, however, the winter wheat is often ready for harvest during the latter part of June. Almost all the wheat is cut by self-binders and is then shocked and left to dry in the field so as to be ready for stacking or threshing. The straw is generally so heavy that from two to three pounds of twine per acre must be used for binding the bundles. Since there is danger of rain during the harvest season, the grain is either stacked or threshed as soon as it is dry. Some few thresh directly from the shock, but inasmuch as there is usually a delay in getting a machine, many stack their grain rather than run the risk of rain while it waits in the shock.

Moderate-sized threshers are used. The ordinary capacity of an outfit is from 1000 to 1500

bushels per day. While larger-sized machinery is used than in the East, yet it is not as large as that used in the West.

*The Wheat Supply and Demand in This Region.*— Ordinarily the Northeast Central Plains region produces about 18 per cent of the total wheat crop of the United States. Illinois, Indiana, and Ohio are large producers. In Wisconsin, however, wheat has declined greatly in importance. The yield in good years for the region averages from 15 to 18 bushels per acre, the five states having nearly the same average yield.

This section is situated very favorably with respect to market conditions. The country is well settled and the roads are generally good. Many of the main traveled roads have been macadamized. A network of railways also places local shipping facilities within easy reach of practically all parts. This region includes many great centers of population, — Milwaukee, Detroit, Cincinnati, Chicago, Cleveland, Toledo, Dayton, Indianapolis, and Columbus, which furnish good home markets. Not only is this region crossed by the great railroad trunk lines which lead to the Atlantic coast, but it has also the benefit of the Great Lakes waterway. Thus it has export facilities which are not excelled by any inland region of like size in the world. The importance of all these factors is shown by the fact that the farm price

of wheat in these states is from 10 to 18 per cent higher than in the states which are west of the Missouri River. The value of a marketing advantage to an exporting region is here well illustrated.

Because of keener demands for some of her other products, this region has not in recent years been increasing in wheat production. The new, cheap lands of the West have increased the supply of wheat, and other products have here become more profitable. Since population is increasing rapidly and the new lands in the United States available for wheat are now largely under cultivation, this condition cannot be permanent. Further development will center about a higher yield per acre rather than more acres, and in such a development this region gives promise of playing an important part.

**The Southwest Central Plains Wheat Region.** — Among the states west of the Mississippi River and east of the Rocky Mountains marked differences in conditions are found from North Dakota to Texas. The transition, however, is a gradual one. In general, the states south of the fortieth parallel have sufficient similarity to be grouped into one region. Of these states, the greatest wheat producer is Kansas, which is followed by Missouri, Oklahoma, Texas, Colorado, Arkansas, and New Mexico in the order named.

The climate here favors the production of winter wheat. The summers are hot. Temperatures in

northern Texas and Kansas in July frequently exceed 100° F. Winters are fairly severe although usually not cold enough to injure the wheat plants. Although the summers show little difference in temperature, the annual average is of course higher in the southern than in northern parts of this region. Rainfall varies from 18 to 35 inches, with a general decrease from the eastern to the western parts. Since certain varieties of plants must secure moisture at certain times, the distribution of the rainfall is an important factor. The greater part of it here is favorable to wheat since it comes during the early spring. There is usually also a sufficient amount of moisture from September to November to give the wheat its autumn growth.

The soil is generally very fertile. Dark, sandy loams prevail, although in Texas and Oklahoma there are some rather extensive areas of reddish soils. Northeastern Kansas and northern Missouri have soils of glacial origin which are fairly free from bowlders. The land varies from gently rolling to broad, smooth plains.

*Methods of Cultivation.* — Winter wheat is raised amost exclusively, and the hard, red varieties are held in highest favor. Turkey Red is the most common, for it yields well and produces grain of high milling quality. Kansas, Colorado, and New Mexico produce some spring wheat, but the crop

is important only in the two latter states. Durum wheat is grown to a considerable extent in the drier sections of the Southwest, especially in western Texas.

The methods of wheat production in the eastern part of the region are similar to those of Illinois and Indiana. Fields are generally of moderate size, and diversified farming is the rule.

In the western parts of Kansas, Oklahoma, and Texas and in the eastern parts of Colorado and New Mexico, wheat is the principal crop. Fields are large, 160 to 640 acres being common sizes of wheat fields. Riding plows are in most general use. The sizes vary from the two bottom to the eight or twelve bottom gang plows with the two or three bottom gangs most common. Early plowing is practiced, and in the drier parts the ground is harrowed soon after plowing in order to conserve moisture. Seeding, by means of ten to sixteen hole press drills, is done usually in October, although in the southern part of the area even November sowing has done well.

*Harvesting the Crop.* — Though the harvest begins in the southern part of the region late in May, June is the chief harvest month. The wheat is cut with the self-binder and the header. The binder is used almost exclusively in the eastern part. Since the header is well adapted to short straw and dry harvest conditions, it is used

extensively in the drier portions of the west. The bound grain is shocked, and much of it stacked before threshing. The headed grain is, of course, handled loose and most of it is also stacked as soon as cut. Occasionally, the wheat is dry enough to be threshed at once. The harvesting machines are

*Courtesy Fort Hayes Branch, Kansas Agricultural College.*

FIG. 107. — Harvesting with a header on the plains of Kansas.

of large size; the binders of 7 or 8 foot cut and the headers of 12 to 20 foot cut.

The labor problem at harvest time in this region is often a serious one. The acreage is so great in proportion to population that importation of labor is necessary. A sufficient number of men is often even then difficult to obtain. This is the most southerly of our great wheat regions and its harvest is the earliest, so here is the first assemblage each year of what is often called the "harvest population." Wages are good. The ordinary prices vary from two to four dollars a day with board and lodging in addition. A working army, made up of men recruited from farms, cities, and

colleges, is here first set in motion and begins its northward march which terminates in Canada in September. Of course most of the men do not follow it from beginning to end. Many do, however, and on the whole a harvest situation is here presented that can be duplicated in no other country. At the end of the season the men scatter, but the next summer sees the same progress of events. Although the new harvest population in the region will present many new faces, the general effect is the same as that of the preceding year.

*Threshing the Grain.* — Steam threshing outfits are used throughout the region. Generally they are of large size, and have a daily capacity of from 1500 to 3000 bushels. Threshing begins in July and is usually completed before October, although since both shock and stack threshing are practiced, the season may be further prolonged.

*The Wheat Supply and Demand in This Region.* — The importance of wheat production in this region is shown by the fact that it furnishes more than one fifth of the wheat crop of the United States. In 1913 it produced 23.3 per cent of the total crop. Because of somewhat deficient rainfall and the lack of intensive farming methods, the average yield per acre is low. It is usually from 10 to 15 bushels, although some sections produce more. This is particularly true of the irrigated fields of

Texas, Colorado, and New Mexico, where yields of 30 to 45 bushels per acre are often reported.

Much export wheat is produced. This region is favorably situated to take advantage of the Gulf of Mexico route to European markets and thus lessen railway transportation. This makes a great difference in freight rates. Galveston and New Orleans are the principal export centers for this region. (See Chapter VIII for comparative freight rates from United States to European markets.)

Land is generally low-priced in proportion to its producing capacity. This, together with easy tillage, has made the cost of production per bushel relatively low. While the farm prices for the wheat are not so great as they are to the east, there is generally sufficient margin between cost of production and the market price to make this a very prosperous wheat growing region.

**The Northwest Central Plains Wheat Region.** — The area between the Mississippi River and the Rocky Mountains which lies north of the fortieth parallel is included under the above head. In this region wheat is an important crop in every state.

In general the summers are hot, and the winters are quite cold. Because of the cold, open winters which prevail, winter wheat can be grown successfully only in the southern and western parts of the area. The rainfall, which varies from 15 to 35

inches, comes chiefly during the growing season and is sufficient in the larger part of the region. In the western part, however, the rainfall is hardly adequate, and so drought-resisting varieties of wheat are sought. There dry farming methods

*Photo by E. L. Currier.*

FIG. 108. — Wheat grown by dry farming methods on the plains of Montana.

are practiced and where water is available irrigation is employed.

The topography is of the rolling plains type with broad stretches of smooth land cut by a few deep river valleys making up the western part. The soil on the whole is fertile and well adapted to wheat. The sand hill area of Nebraska and the Bad Lands of South Dakota are conspicuous exceptions. There are also some mountain areas, such as the Little Laramie, the Black Hills, and

the Little Missouri Mountains which mark districts not suited to wheat. The greater part of the western portion was formerly the land of cattle ranges and much of it is still so used. During recent years, however, wheat has made serious inroads on the grass land.

*The Methods of Cultivation.* — Both spring and winter varieties are raised. North Dakota and Minnesota lead in spring wheat production and Nebraska leads in winter wheat. In Iowa and in eastern Nebraska, corn is the most important farm crop, but in the other states wheat takes first place.

Since methods of production in the eastern part of the region are about the same as for the Northeast Central states, detailed discussion need not be given here. In the western section, however, the work is for the most part done on a large scale. The plowing is with gang plows varying in size from two to sixteen bottoms. The larger plows are pulled by either steam or gas tractors and the smaller ones by horses or mules. Nearly all the plowing is done in the autumn. Ten to eighteen hole press drills are used for seeding, and about a bushel of wheat is sown per acre. Most of the winter wheat is sown in September. The spring wheat is sown late in March or in April. Where the soil is quite loose, the winter wheat land is sometimes rolled in the spring in order that the

soil, which has become much loosened by the freezing and thawing of early spring and winter, may be solidly packed together.

*Harvesting the Crop.* — The self-binder is the harvesting machine in highest favor. Headers are used to some extent, particularly, as often happens in dry years, when the wheat is very short. July and August are the harvest months, the southern part having, of course, the earlier date. Most of the wheat is shocked, and in the west very little of it is stacked. Threshing is out of shock, and is usually done as soon as the wheat is dry enough. Under this method, everybody wants to thresh at about the same time and consequently many large-sized threshing machines are owned in each community. Consequently in this region the threshing season is a short but extremely busy one. All the machinery, both harvesting and threshing, is of large size and great capacity. Thus, as a result of large fields and a scattered population, the amount of human labor necessary to produce a bushel of wheat is reduced to the minimum.

*Marketing the Crop.* — The Northwest Central Plains is a region of numerous country elevators. The wheat is all marketed in bulk. Many farms are likewise equipped with granaries in order that the farmer may hold his product for favorable market conditions. The wheat is hauled in wagons of 50 or 60 bushels capacity either direct from

thresher or from the granary to the nearest railroad. One driver, by driving one team and leading the other, often handles two loads. Every town has one or more elevators. The load is driven upon a hinged platform, the rear end gate drawn, the wagon tilted downward at an angle of 45° and the wheat dumped into a pit, from whence it is elevated and discharged into railway cars.

FIG. 109. — Twenty stacks of wheat in one setling, Nebraska Loess Plains.

In this region there is operated a complete chain of wheat-producing conveniences. It will be observed that the ground is prepared, the seed planted, the harvest, threshing, and marketing performed, with but very little manual labor involved. Power (either horses, steam, or gas) and machinery, under the direction of man, do practically all the work.

The yield per acre is from ten to twenty-five bushels and the total production is about 38 per

cent of the entire wheat crop of the United States. Since this is a region of scattered population and heavy production, it is evident that it contributes materially to the export trade.

The greater part of the wheat is sent eastward, either by way of the Great Lakes highway or by rail. Transportation facilities are very good; the greater part of the region is served by a maze of railroads. Splendid transcontinental systems give efficient service to the eastern and southern export cities. Milling is well organized. Up-to-date flouring mills are found in all the cities and in practically all of the moderate-sized towns. In addition to these smaller centers there is the great milling center at Minneapolis. The principal market centers for the region are Minneapolis, Chicago, Omaha, Kansas City, and St. Louis.

**The Western Valleys and Plains Wheat Region.** — Wheat is raised in all of the Western states. Although it is of great local importance in the irrigated valleys of Arizona and Utah, its areas of great commercial importance are the Sacramento valley of California and the high plains of eastern Oregon, Washington, and western Idaho. These two latter areas are the districts which contribute to the wheat of commerce.

The climate varies greatly. In California the winters are very mild, and in eastern Washington they are quite severe. The average annual rain-

fall in the wheat-growing section is from ten to forty inches. As it comes mostly in the winter season, the harvests are fairly free of rain.

The topography varies from the broad river valleys of California to some very broken lands in Washington. Although the soil is rich in mineral constituents in some places it is somewhat low in humus.

*Methods of Cultivation.* — Because of climatic and soil conditions practically only soft, white wheats are grown. Winter wheats predominate in California and Oregon, and spring wheats in Washington. Club wheats are the most common, and are in favor because of their early maturing and non-shattering characteristics.

The plowing is much the same as in the plains regions, except that, in California, disc plows pulled by steam engines are used to a considerable extent. The use of these discs is not so common as in past years, since many of the large farms have been subdivided into smaller units. Plowing is done during the autumn, and in California, whenever weather permits, may be carried late into the winter. The plowing in this region comes in the rainy season. In some parts disc harrows and even steel-tooth harrows are used for preparation of seed bed in lieu of plowing. This of course is a quicker and cheaper method, but it ordinarily results in lower yields.

FIG. 110. — The combine at work in California. A view typical of the wheat harvest in Oregon, Washington, and Idaho as well.

The time of sowing is from September to April. The latter date is true for the northern part of the spring wheat district. The grain is sown either by broadcast seeders located on wagon flats or by disc drills. Broadcast sowing is more rapid than drilling, but it does not result in an even covering of the grain.

*Harvesting the Crop.* — Binders, headers, and combined harvester-threshers are used for harvesting the wheat. The harvester-thresher, known as the combine, is used only where the wheat farms are very large. Elsewhere headers and binders predominate. Since most of the farms of the Sacramento valley have been subdivided into smaller units and are given over to intensive, diversified farming, eastern Oregon is now the most important large-farm wheat district. In the smaller farms of the Sacramento valley, wheat is coming to have only a subordinate place among the crops, and wheat production has decreased since 1900 about 80 per cent. In the large-farm district of Oregon, however, the average field covers from 640 to 1000 acres, while farms exceeding 5000 acres are not uncommon. In some counties more than half the farms exceed 1000 acres in size. There the combines are used almost exclusively, and the common self-binder is seldom seen. Since the successful use of the combined harvester-thresher depends on large-sized farms

and a rainless harvest season, eastern Oregon and parts of Washington and California, fulfilling both conditions, find this machine the practical one.

Threshing in all cases follows directly after the harvest. When the binder is used, the grain is threshed very soon after it is cut. When the combine is used, the binding and threshing are of course one operation. For the threshing only large-sized machinery is used. The wheat must be delivered to market before the autumn and winter rains begin, but since the dry season extends late into the fall, ample time for marketing is available. The harvest here is not marked by the nervous haste which prevails throughout the Central states.

*The Extent of Production.* — The yield per acre of this region is high, averaging from 14 to 28 bushels. This high general average is partly due to the immense return from irrigated valleys in the region where yields often run 40 or more bushels per acre. The cost of production of non-irrigated wheat is relatively low. It is estimated at from seven to ten dollars per acre. The former figure applies to places where the ground is merely harrowed instead of plowed before seeding. About twelve per cent of the crop of the United States is raised in this region.

*Marketing the Crop.* — Wheat here is handled almost entirely in sacks. There are no elevators

at the country towns; and the seaports, Seattle, Vancouver, and Portland, in place of having large terminal elevators such as are seen at Chicago or New York, have erected great warehouses in their stead. At the thresher the grain is put into sacks holding about two bushels and is then hauled to

*Courtesy of New Chamber of Commerce, Seattle.*

FIG. 111. — Along the water front at Seattle.

the railway station. Farmers are not equipped with tight wagons, and farm storage is almost unknown. Sometimes the sacked grain is stacked in piles alongside the railroad where it awaits shipment. On the whole this method of handling wheat is more expensive than the handling of it in bulk, and so the present tendency is to provide for the more economical method. Since this change

means replacing open wagons with tight ones, warehouses with elevators, and the present storehouses with modern terminal shipping facilities, it must of necessity come slowly.

Farm prices for wheat are about the same as in

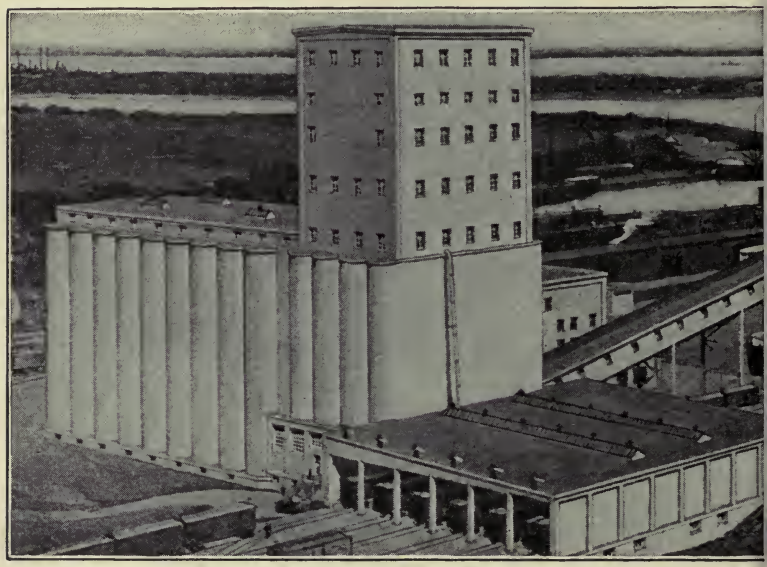


FIG. 112. — A large grain elevator at Girard Point, Philadelphia. Capacity, 1,000,000 bushels.

Kansas and Nebraska. Although some is sold to Asiatic markets, the greater part of the export wheat is sent by all-water route to Europe. The Panama Canal will greatly lessen the distance to Europe and will probably result in lower freight rates. This, by making possible somewhat in-

creased prices for his product, will be of decided advantage to the producer. Thus, with the rapid growth of Pacific coast industries, the development of Oriental markets, and the lowered freight rates to Europe, the future of this wheat region

*Courtesy of Pennsylvania Railroad.*

Three ocean going steamships can be loaded at the same time at the rate of 60,000 bushels per hour.

seems promising. More intensive farming methods will also gradually win favor and the result will be that general production and prosperity will become even greater than at present.

**The Exportation of Wheat in the United States.** — In common with other exporting countries, the

United States finds her greatest wheat market in western Europe. The price of wheat to the American farmer depends very largely on the demand which European countries make upon his product. Thus large crops in other exporting countries, such as Australia, Argentina, Canada,

*Courtesy of New Chamber of Commerce, Seattle.*

FIG. 113. — Elevators are being built along the waterfront at Seattle. The one in process of construction at right of picture will have storage capacity of five hundred thousand bushels.

India, and Russia, cause a lessened demand for our wheat and lower prices result. The price likewise depends to a large extent on the crops in the chief importing countries: Italy, Germany, France, and Great Britain. Bounteous crops in these countries render large imports unnecessary and lower prices naturally follow. In a similar way the greater

imports needed when their home production is low causes high prices. So dependent on imports are the European countries that even threatened shortage in home production causes sharp advances of the wheat market. As an illustration of this the lessened production anticipated in these countries as a result of the European War caused in 1914 the price of wheat in the United States to rise from 25 to 40 per cent, although this was a year of an exceptionally large world crop. However, since prices rose as soon as war became imminent, part of this rise was undoubtedly due to speculation. Prices remained high because of the increased demand for wheat. This demand was at first based on prospective future needs rather than on needs actually existing.

The armies of Europe, from the Napoleonic wars of the early nineteenth century to the present time, have largely depended on foreign wheat for their breadstuffs. The United States now, as before, is an important contributor to their supply.

The wheat exports of the United States are both the grain and flour. This is the only great wheat-exporting country which contributes nearly as much wheat flour as wheat grain to foreign commerce.

The United States has, however, passed the period of its development in which it ranked fore-

most as the source of wheat supply for foreign nations. The total production, though steadily advancing, has not kept pace with the consumption. In 1900 this country far outranked every other in the amount of its wheat exports. That year she sent approximately 216,000,000 bushels to foreign markets, a quantity three times that of the wheat exports of either Argentina or Russia in the same year. Since that time the wheat exports of the United States have decreased approximately fifty per cent. This is in spite of a slightly increased total production. The cause of this decrease in exports lies in the tremendous growth in city population during recent years. This growth is largely due to heavy immigration. Prior to 1900 our free or cheap lands attracted north Europeans and produced a rapidly expanding farming population. Immigration of this type is more important as a wheat producer than as a bread consumer, hence it created a large wheat surplus for export trade. The greater part of the immigrants since 1900 have been south Europeans who have been attracted to cities rather than to the farms, and so have become important as wheat consumers but not to any great extent as producers.

However, the situation is not discouraging. The limit of production in this country is not yet realized. With a better understanding of farming

methods, lands made productive by irrigation and by drainage, and crops which are better adapted to climatic conditions, the future is secure. The United States can double her present wheat output and do it profitably as the demand for wheat increases. As an exporter of wheat she must give way to the less densely populated countries, Australia, Argentina, Canada, and Russia. This is in line with progress. The greater demand for wheat at home is due to the increased number of people to be fed. These people are actively engaged in various industries, and as a result of their activities we are able to contribute to commerce, instead of raw materials, the finished product of mill and factory.

### Questions and Exercises

1. Give some of the reasons which have led to the great importance of wheat production in the United States.

2. Why is wheat of little importance in New England?

3. Suggest reasons why the first centers of extensive wheat production were in the valleys of the Delaware, Susquehanna, and Mohawk rivers.

4. In general what is true of culture methods in the Northeast region? Account for the high average yield of wheat there.

5. What states of the Southeast region rank highest in wheat production? In what part of the region are they situated?

6. Why are wheat prices comparatively high in the Southeast region?

7. Summarize the conditions which favor wheat production in the Northeast Central Plains region.

8. Explain why winter wheat is in such high favor in the Southwest Central Plains.

9. Suggest reasons why climatic conditions favor the production of hard wheats in Kansas and of soft wheats in the Eastern states.

10. In what parts of the United States is Durum wheat raised? Why is it not grown more extensively?

11. To what conditions is the header best adapted?

12. Why is threshing out of shock more prevalent in the Western great plains than in the Eastern states?

13. Why is the farm price per bushel of wheat lower in the Western great plains than in New York?

14. Explain why the combine is used so extensively in Oregon and adjacent states.

15. What are the principal highways for wheat transportation in the United States?

16. What foreign countries serve as the markets for the export wheat of the United States?

17. What are the chief wheat export cities? Where are they situated?

18. Explain how the price of wheat in the United States is related to the crops in other exporting countries.

19. Suggest reasons why the percentage of flour exported by the United States is relatively high.

20. What are the principal commercial routes for American wheat and flour?

# CHAPTER XV

## *WHEAT IN CANADA*

While the Dominion of Canada lies north of the United States, one part, the peninsula of Ontario, extends southward to about the latitude of central Iowa. The northern part, however, lies beyond the Arctic Circle and its extent east and west is more than 3400 miles. The area thus exceeds that of the United States even including Alaska. These facts serve to suggest the reasons for the great diversities in soil, topography, and climate which exist in that country.

**The Canadian Wheat-producing Area.** — Nine tenths of the wheat-producing area of Canada lies in the south-central part, just north of the states of North Dakota and Montana. Some wheat is grown in the southeast provinces, Ontario, Quebec, and New Brunswick. There its importance is slight, however, compared with the area to the west. Eastern Ontario is a region of diversified farming. The farms are small and much attention is given to fruit raising, especially to apples and grapes.

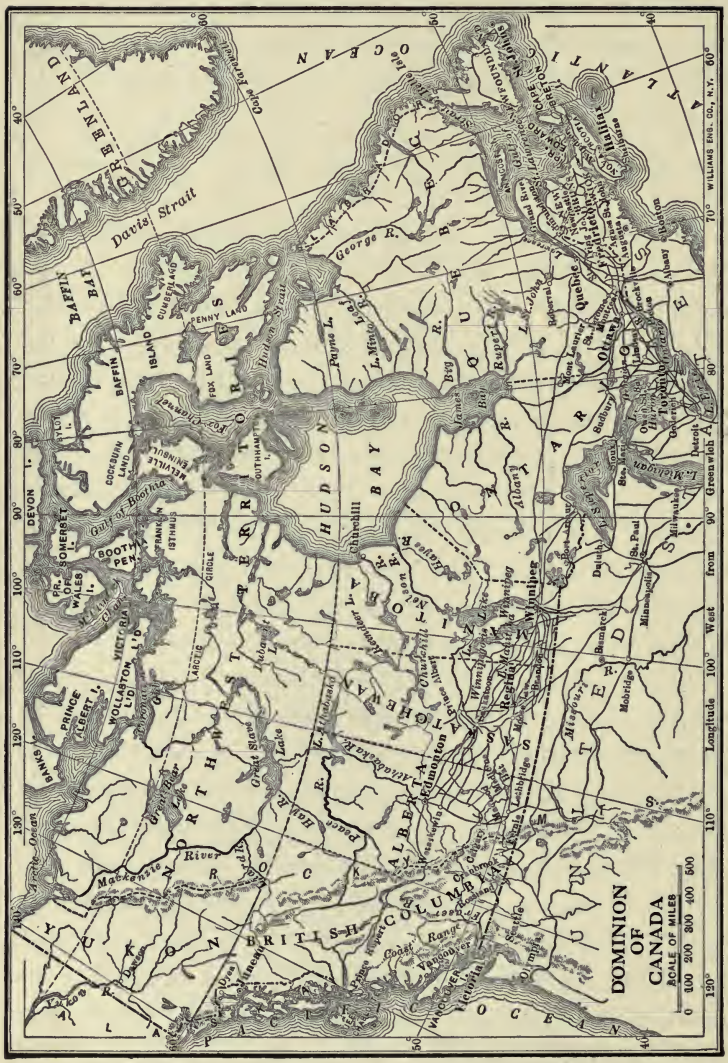



FIG. 114. — Map of Canada.

Manitoba, Saskatchewan, and Alberta are the great wheat provinces of the plains, and many valleys in the mountainous province of British Columbia are likewise well adapted to wheat growing. The climate is the chief control. The normal annual rainfall is about 22 inches in Manitoba, and from 16 to 18 inches in Saskatchewan and Alberta. The rainfall, although not high, is usually sufficient because the greater part of it, 50 to 65 per cent, occurs during the growing season. June is the month of greatest rainfall. The summer temperatures are quite high, often reaching 90° F.; and winter temperatures vary considerably in the different parts of the provinces. Southwest Alberta has a milder winter than districts to the east and north. This is due primarily to the chinook winds, — westerly winds, which upon descending the mountains are warmed by compression, and thus reach the plains quite dry and warm. The average winter temperatures in different localities from December to March are: Calgary 17.1°F., Fort Chipewyan (northeast Alberta) – 5°F., Winnipeg 1.7°F. Another important climatic factor is the high percentage of sunshiny days. This high average of sunshiny days and the fact that on these days the period of actual sunshine is from 16 to 17 hours make an ideal condition for rapid growth. In fact more rapid growth may be made here than under con-

ditions farther south, where the daily period of sunshine is several hours less. Thus it will be observed that climatic conditions favor good yields of very high grade wheat, since sufficient rainfall occurs in the early stages of growth, and warm, bright, sunshiny weather prevails during the later growth stages and through the harvest.

The prairie soils of Canada have become widely known because of their fertility. Generally they are deep, dark colored, and mellow. They contain, as a rule, large percentages of all the essential constituents required for wheat, and are also characterized by exceptionally high humus and nitrogen content. This may be accounted for by a rainfall sufficiently high for plant growth but not high enough to cause heavy leaching.

**The Kinds of Wheat raised in Canada.** — Since severe winters are prevalent over much of the Canadian wheat belt, spring wheat is the type most widely grown. Hard spring wheats are common in Manitoba, in the greater part of the Saskatchewan, and in upper Alberta. Soft spring wheats are grown in Quebec and New Brunswick. Hard, winter wheat is raised in southern Alberta, while soft winter wheats are grown in western Ontario and British Columbia. Because of its drought-resisting properties, some Durum wheat is produced in southern Alberta and southwestern Saskatchewan. Thus it will be observed that the

hard wheats are grown where there is moderate rainfall and warm, sunshiny summer weather, and the soft wheats are grown under more humid conditions. The winter wheat district of Alberta is a region of mild, open winters, and the winter wheat of Columbia and western Ontario is grown in regions where heavy winter snows protect the soils from low temperatures.

Among the many varieties of wheat raised in Canada the most generally known of the spring wheats are the Red Fife and the Blue Stem. The latter was introduced from Minnesota and although it is a good producer, it has failed to become well adapted to Canadian conditions. The Red Fife is at this time the most popular spring wheat grown. The kernels are pale red, plump, short, and hard. This variety is remarkable for its high quality, its productiveness, and its power of adapting itself to varying soil and climatic conditions. Among the hard winter wheats, Turkey Red, Kharkof, and Alberta Red are best known. The latter has proved very popular in Alberta.

**The Culture Methods.** — Although intensive farming prevails in parts of the eastern provinces, the great wheat crop of Canada is raised where fields are large. The usual size of the farm is from 160 to 640 acres, but fields of several times that extent are not uncommon. The farmers are

generally men who, with some capital, have gone there from the United States or else they are progressive north Europeans. Large farms handled by intelligent labor and the use of modern machinery characterize the wheat industry of Canada.

*Plowing and Seeding.* — In the eastern part of Canada a great part of the plowing is done with

*Courtesy Canadian Pacific Railroad.*

FIG. 115. — Plowing for wheat in Canada.

the small walking plow. This does not hold true for the west, however; there the two-bottom gang plow, drawn by five horses, is the most common, and the eight and twelve bottom gang with a steam or gas tractor is not an uncommon sight. Since in this country the season in which plowing can be done is short, the work must be pushed rapidly. For winter wheat the ground must be

plowed as soon as possible in the fall. This permits the early seeding which is necessary to give the plant its required autumn growth. Even for spring wheat it is customary to plow in the fall, since earlier seeding in the spring is thus made possible. After plowing, the ground is dragged by wide steel-tooth harrows. Sixty to seventy acres is an ordinary day's work for one man. After harrowing, the seeding is then done by means of large press drills. About a bushel to a bushel and a half of seed wheat is used per acre, and one man can sow about 30 acres per day.

*Harvesting the Crop.* — After seeding no further care is necessary until harvest time. The winter wheat harvest begins in July and runs through August. The spring wheat harvest begins in July in Ontario and much of it, especially in the northwest, is not finished until September. In some sections the harvest comes so late that the crop is occasionally injured by frost before it is ripe. In such sections early maturing varieties are naturally favored.

The harvest is the busy season. Then the work is rushed, labor is in demand, and long hours are the rule. When the wheat ripens it seems as though all the fields in the vicinity should be cut at the same time. If cut too early, the wheat suffers serious loss from shrinkage; if delayed too long, the grain shatters and is wasted. The labor

which was adequate to do the plowing and planting is wholly insufficient to handle this enormous and immediate work. Importation of labor is necessary. As noted before (Chapter IV) there is in North America a class of labor which follows the harvest as the wheat ripens from the south to the north. This work begins in the southern part of the United States in June and crosses into Canada with the ripening grain. Although the men who follow this are not skilled laborers, they are at least trained to their work. Ordinarily they are steady and industrious. Among their number will be found many college students who spend their summers working in the harvest fields. The work, though hard, is healthful, and the wage, usually from $2.50 to $4.00 per day and board, is above the average for unskilled labor.

Most of the wheat is cut by self-binders. The binder which takes a seven or eight foot swath is the one most commonly in use. With this machine, by changing horses and working as high as sixteen hours, one outfit can cut from 25 to 40 acres per day. When labor is available the wheat is shocked. It is often, however, left to dry out on the ground. Of course this is true only of the western plains section where the harvest season is usually quite free from rain. Practically none of the grain is stacked but is allowed to remain in the field until it can be threshed. The header is seldom used

since, when the wheat is cut, it is not dry enough to be threshed. It frequently is not dry enough even to be put into stacks. In this region it has been found that the best results are obtained by allowing the wheat to become thoroughly dry in the shock. This fact accounts for the almost universal use of the self-binder in Canada.

*Courtesy Canadian Pacific Railroad.*

FIG. 116. — Harvesting wheat in Canada.

*Threshing the Grain.* — The wheat is hauled from the shocks to the steam threshers. The sizes of the machines vary greatly. Some have a daily capacity of 3000 or more bushels, others less than a thousand. The threshers are usually not owned by the individual farmers, but by some farmer in the neighborhood who hires his farm work done while he devotes his time to running the threshing machine. A careful and businesslike operator may make money in this way. Generally

the thresherman hires his own help so that he thus operates a crew. He then engages to go into a man's field, gather the shocked grain, thresh it, and deliver it to the wagon at a stated price per bushel. The men of the outfit are generally well paid, $2.00 to $3.00 per day with board and lodging being the customary wage. A cook wagon or tent is in this case a part of the regular equipment.

Because of the abundance and cheapness of straw as a fuel, straw-burning engines are often used for power. An expense is added, however, since, when straw burners are used, one man is kept busy firing the engine.

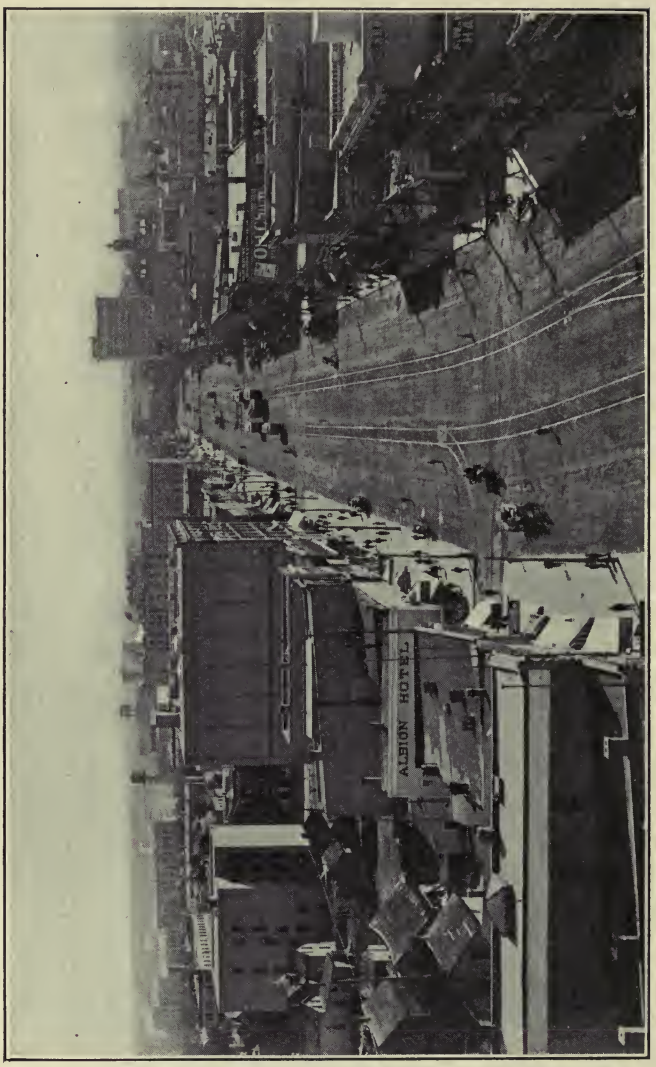
When the grain is threshed, the separator delivers it into large wagons, sometimes called wheat tanks, which hold 125 to 140 bushels. The wheat is than hauled direct to the local elevator and shipped to market. There is very little local storage either in farm granaries or in sacks in local warehouses.

*Marketing the Crop.* — In the years following 1900, development of wheat territory was more rapid than that of railway facilities. This resulted in serious losses since no adequate provision existed for local storage. Wheat was left on the ground in large piles beside the railroad tracks awaiting cars for shipment, and the delay was often so great that large quantities were damaged. In

late years the railway facilities have improved to such an extent that in the future such difficulties are improbable.

The general practice of the farmer here is to sell his wheat directly to the local elevator for cash. Where competition in buying exists this results in a fair price to the producer. Where, because of monopoly in ownership or operation of line elevators, there is no competition, prices have not been held to a reasonable figure. In order to meet such a condition, coöperative companies have been organized which ship their own wheat and sell it through commission merchants.

The great market center of Canada is the city of Winnipeg. There most of the grading and inspecting of wheat is done, and a large Board of Trade has been organized. The importance of this city is partially due to the fact that it is situated at the confluence of two navigable streams, the Red River of the North and the Assiniboine. Another and probably a larger factor which makes it important is that it is the converging point of the great Canadian railways. These factors cause the bulk of Canadian wheat shipments to pass through Winnipeg. Because of this fact it has become an inspection point, — wheat cars are there opened, samples are taken and graded and then used as a basis of sales. The great elevators which mark the places of transfer and




*Courtesy Canadian Pacific Railroad.*

FIG. 117. — Winnipeg.

the unloading of the freight cars, however, are located at Fort William and Port Arthur, over 400 miles to the east on Lake Superior.

Regina, Calgary, and Edmonton are likewise cities which have come to be of considerable importance because of the development of the wheat industry in various Canadian regions.

**The Extent to which Wheat is Produced in Canada.** — The large plains of Canada seem to be as well adapted to wheat growing on a grand scale as any similar area in the world. Extensive, undeveloped wheat tracts lie in northern Alberta and Saskatchewan. Likewise many valleys in British Columbia are also thought to be well adapted to extensive wheat growing.

The total production in 1913 was reported to be 231,717,000 bushels; in 1902 it was 100,523,000 bushels. Thus in a decade there is shown an increase of more than 125 per cent. The average yield in 1913 was 21.04 bushels per acre. This is a low average, rather lower than the average yearly yield, for 1913 was not a year of exceptionally good crops. Yields as high as 40 bushels per acre are not unusual in the wheat districts west of Winnipeg, although on the other hand the crops are sometimes reduced by drought or frost so that 10 or 15 bushels per acre is all that is produced. In these regions, however, because of the favorable soil, climate, and intelligent methods of farming,

the general average production per acre is high. It even exceeds by five or six bushels the average yield in the wheat regions of the United States.

Since the cost of production must include delivery to local markets, the profit very often is influenced by the condition of the roads at marketing season. In the newly settled regions, road building is not far advanced and distances to markets are often great, — as much as twenty or thirty miles in some instances. The local marketing conditions vary so greatly in different sections that any average costs of marketing that could be stated would have little value.

Canada wheat lands have been low priced in proportion to production values. It is evident when one considers the interest on the money invested that wheat can be raised more cheaply on land that sells for $10 or $15 per acre than on land valued at $150.00 per acre. At this time, with the low-priced land and the high yield of wheat, the average cost of production in Canada is estimated to be about 40 cents per bushel. This, however, does not include expense of marketing. Of course, as the land becomes higher priced the cost of production will be relatively increased.

**The Exportation of Canadian Wheat.** — Canada has become one of the great wheat-exporting countries of the world. Her exports of wheat and flour are now nearly as great as those of the

United States and the indications point to even greater progress in the future. She exports annually nearly one half of her total wheat crop, most of which goes to the mother country, Great Britain. Of her wheat exports only about one fifth is in the form of flour, whereas flour constitutes

*Courtesy Canadian Pacific Railroad.*

FIG. 118. — Grain elevators in Canada.

nearly one half of the wheat exports from the United States. This difference partially results from the rapid extension of wheat growing in Canada, which has been so rapid that milling has not been able to keep pace with it. It is further a result of the fact that flour can be made more

cheaply in England than in the New World, since milling is there well developed and labor is cheaper. Canada exports at present from 30 to 50 per cent more bushels of wheat annually than does the United States. On the other hand she exports only about two-fifths as many barrels of flour.

Extensive preparation has been made to care for and develop this export trade. Canada has five great railways whose chief interest lies in the wheat traffic. Of these, the Canadian Pacific, the Canadian Northern, and the Grand Trunk are the most important. The Canadian Pacific connects the Atlantic coast with the Pacific. It also furnishes a direct line from Winnipeg to Fort William and Port Arthur, the Lake Superior terminals of the wheat traffic. The Grand Trunk connects Winnipeg with Montreal and Quebec, and Portland, Maine. Its summer port is Montreal, and its winter port, because of the ice-bound St. Lawrence, is Portland. It has recently built a western line to Prince Rupert by which it connects the wheat fields of Canada with the Pacific Ocean. This connection with Pacific ports will provide an all-year water highway for export trade, and shipments of wheat can then be made from western Canada by way of the Panama Canal across the Atlantic to England. This will prove a great benefit to the wheat regions of the Canadian northwest, for they can then reach Euro-

pean markets much more cheaply than by the long railway haul to eastern ports.

The natural outlet for Canadian wheat is the Hudson Bay route. There is, however, even in the summer the ever present danger of ice in Hudson Strait, and the whole route is ice-bound during much of the season when it is most urgently needed for the wheat trade. The same is true to a large extent of the St. Lawrence. Only a part of the year's export can be sent by way of Montreal and Quebec before the river freezes over. This results in the fact that much of the Canadian wheat is sent through part of the United States "in bond." This means that the wheat is not to be sold in United States markets, and that it is permitted to pass through this country only to reach an export city, where it is to be loaded into vessels and sent to foreign markets. We can thus see how Canadian climatic disadvantages serve to assist the carrying trade of this country and increase the volume of business of some of our Atlantic seaports. The cities which gain most by this condition are Portland, Boston, New York, and Baltimore.

### Questions and Exercises

1. Where in Canada is the greater part of the wheat-producing area?

2. Explain how the climate of this part favors the production of high grade wheat.

3. In what parts of Canada are winter wheats successfully grown? What climatic conditions prevail there?

4. In general how do cultural methods of Canada compare with those of the United States?

5. When does the harvest season come? Why are early maturing varieties of wheat desired in some places?

6. Explain why imported help is necessary at harvest time in order to care properly for the crop.

7. Why is large-sized harvesting and threshing machinery in such general use in the wheat fields of Canada?

8. Of what importance has modern machinery been in the development of Canadian wheat lands?

9. Explain how railroad development has affected the wheat industry of Canada.

10. What is the great wheat-marketing center? What causes have contributed to the supremacy of this city?

11. Of what importance are Fort William and Port Arthur? Where are they located?

12. How does the total production of wheat in Canada compare with that of the United States? the average yield per acre?

13. What country serves as the chief market for Canadian wheat? Why is most of the wheat exported unmilled?

14. Trace the trade routes of Canadian wheat to European markets.

15. Give a brief report on the importance of Canada as a wheat producer, present and future.

# CHAPTER XVI

## *WHEAT IN ASIA*

That Asia, the home of early civilization, should be important as a wheat producer is to be expected. Wheat is the most universally grown cereal on that continent. To its early culture there and the favor in which it was held, this grain owes its high place in history and literature. Asia has presented wheat to the world as symbolic of goodness and prosperity.

Though wheat is produced in nearly every country of Asia, only two Asiatic countries are important contributors to the wheat of commerce. The reason is twofold: first, the dense population which prevails over much of the territory uses the local output; and second, the primitive methods of production which are still in vogue limit the total yield. In China, Palestine, and the valley of the Euphrates, wheat is produced by nearly the same methods as were used two thousand years ago. It is a singular fact that the only two countries in Asia which export wheat are the two which have most strongly felt European influence, —

Asiatic Russia and India [See map, Fig. 57]. This becomes more significant when one considers that these countries are typical of the northern and the southern parts of the continent.

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FIG. 119. — Threshing scene in the Holy Land.

**The Wheat Region of Asiatic Russia.** — *Location and Extent.* — Russia in Asia may be considered in three grand divisions: Siberia, which is roughly estimated to contain 4,833,500 square miles; Central Asiatic Russia, which includes Turkestan, Transcaspia, Bokhara, and Khiva,

with a total of 1,120,000 square miles; and the Transcaucasus province lying between the Black and Caspian seas.

*The Wheat Area in Siberia.* — Siberia is larger than all Europe. In population, however, it but slightly exceeds one person per square mile. It extends across Asia in approximately the same latitude as Canada. It is estimated that there are about 500,000 square miles of fertile, black soil which is well adapted to cereal production. Two hundred twelve thousand square miles of this soil lie in west Siberia, and about 288,000 square miles in east Siberia. Of the 103,283,000 bushels of wheat produced by Asiatic Russia in 1912, Siberia contributed much more than one half. This is further localized in that at present the principal grain-producing regions are those in the western part of Siberia.

*The Climate and Soil.* — In all the producing area the two chief factors to be considered are latitude and altitude. Of course in each case this is largely a temperature control. The high plains to the southeast because of their altitude suffer from early frosts so frequently that grains cannot be depended upon to mature. Likewise in the lowlands of western Siberia the climate is unfavorable for successful cultivation north of 61° north latitude. The principal agricultural region thus lies between parallels 55° and 57°. This

is the zone where the northern forests gradually merge into the dry steppes of the south. This belt is over 100 miles in width from north to south and has an extent from east to west of more than a thousand miles. The soil is a fertile, black loam. Of this vast area only about 3 per cent is at present being farmed. Immigration from European Russia has been going on rapidly, however, in recent years, to such an extent that nearly half a million people settled in this part of Siberia in a single year. Farther eastward development has not been so rapid as in the west.

*The Machinery of Cultivation.* — The tools and implements of the Siberian peasant are of crude and primitive types. The plow is large and clumsy and is usually homemade. It turns a wide furrow but in order to do so it requires the combined strength of 3 to 8 yoke of oxen or teams of horses. Sowing is by hand, and crude harrows are used to cover the grain. Almost all of the wheat raised is of spring varieties. Of late, however, modern methods are gradually being introduced. American harvesting and threshing machine firms are engaged in an educational campaign which is designed to stimulate to better methods of production, and thereby create a demand for their machinery. Modern threshers are also to some extent replacing the flail and threshing floor.

*The Extent of Production.* — Though the amount of wheat produced in Siberia is steadily increasing, the rate of increase is but little greater than that of local demand. It is thus easily seen that unless the cultivated area is increased much more rapidly than it has been in the past, and unless more efficient methods of production are introduced, the amount of export wheat from Siberia cannot be expected to show a very rapid increase.

**The Wheat Region of Central Asiatic Russia.** — This area is sometimes called Turkestan. It is located east of the Caspian Sea and includes a stretch of land which has an extent of nearly 1600 miles east and west and from 500 to 700 miles north and south. Physically it consists of two very distinct divisions, — the eastern mountain and plateau region and the western low-lying plains. In these plains there is a great deal of loess soil.

The climate is dry and characterized by great extremes of temperature. Although it is the same latitude as Sicily, the winters are cold, and the summer temperatures often exceed 100° in the shade. The winter winds are likewise strong and so the snow that falls is usually blown into drifts. The annual rainfall is but 11 inches, and most of this falls in the higher altitudes. The snow and rainfall of the mountains, however, furnish a continual flow of water in the rivers which traverse

the region and large irrigation projects are thus made possible. In the province of Bokhara the Amu River furnishes water for thousands of highly productive acres which, were it not for irrigation, would be barren wastes. It is estimated that in this region nearly 4,000,000 acres are now cultivated under irrigation.

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FIG. 120. — Threshing wheat in Turkestan.

*The Methods of Cultivation.* — Old methods of cultivation are here also still in vogue. In any part of the country it is a common sight to see a camel and an ox yoked together, making a team which pulls a primitive plow across the field. The harvesting is done by the sickle and men laboriously cut the grain by creeping along on their knees. They are followed by others who pick up the grain stalks and bind them into sheaves. These wheat sheaves are then loaded upon the backs of donkeys, camels, or men and are carried

into huts made of dry mud. There they are placed in storage until threshing time. The bundles are then loosened; the stalks of grain are spread over the floor; and the wheat is tramped from the straw by the hoofs of cattle or donkeys which are driven over it. Modern threshers have not yet found their way to this part of Asia.

In noticeable contrast to European countries is the fact that the work in the fields is all done by men. Mohammedan restrictions forbid outdoor labor for women.

The available statistics for this region give 18,104,000 bushels as the average annual production for the years 1901–1908 inclusive. Reliable data are impossible to secure and so the above is thus very little better than an estimate.

**The Wheat Region of Transcaucasia.** — Under this head is included the land which lies between the Black and the Caspian seas, an area of approximately 180,000 square miles. This country has also a diversity of topography, soil, and climate. Since the broad valleys of the eastern slope are deficient in rainfall, they are not extensively cultivated.

The western slope, on the other hand, with fairly dependable rainfall and a fertile soil, is one of the richest parts of the Russian Empire.

*Methods of Cultivation and Transportation.* — Agricultural methods are primitive here also and

homemade implements are used. Wooden plows, hand sowing, reaping by means of scythe or sickle, and flail threshing, are the common operations. Because so much hand labor is available and because the work is so well done, the country produces large crops of wheat, as well as of other cereals, in spite of the primitive methods in vogue.

The development of any country is largely dependent upon its transportation facilities. Nowhere has this fact been better demonstrated than in the case of Asiatic Russia. The isolation here has been largely due to lack of adequate means of commercial intercourse. The country, has, however, two great transportation agencies that must be considered, — its railways and rivers.

Of the Trans-Siberian Railway it has been said, " It is destined to have a more far-reaching political and commercial influence than any industrial and economic scheme that has ever been executed." This great railroad extends from Moscow in Europe to Vladivostok on the Pacific coast. In its total length of 6100 miles it traverses central western Siberia and extends the entire length of the south border of eastern Siberia. It furnishes an outlet both to the east and the west for this enormous territory which it serves.

To the south has been built the Transcaspian railway. It bears the same relation to Turkestan that the Trans-Siberian railroad bears to Siberia.

That its influence is being felt is evidenced by the fact that even now the caravan trade of the east is being diverted from India into Russia. Both of these great railways were built primarily as military lines, but they are fast becoming highways of commerce.

Siberia is characterized by her long rivers, among which the chief ones are the Obi, the Yenisei, and the Lena. The main trunks of these streams extend southward 1000 to 1200 miles and, with their tributaries, spread fanlike through an immense area of country. The great drawback to all the Siberian streams is that they flow northward into a frozen sea. In spite of this fact transportation, developed along the upper courses, may be made tributary to railway lines. This will partly solve the problem for a vast area of country. Since the whole region is a vast plain, the construction of roads will not demand any great amount of engineering skill. Siberia, indeed, is a country of vast and magnificent distances.

Most of the wheat exported from Siberia is shipped by rail through European Russia to the countries of western Europe. The principal markets have been in Germany. The export trade has been hampered by lack of railroads, and recent development has only partly overcome this difficulty.

Commercially, wheat in Asiatic Russia is more

important because of its future prospect than for its present supply. There are vast areas of cheap, unused land which are fairly well adapted to wheat raising. With the cultivation of these lands and the building of railways and canals, Asiatic Russia gives promise of producing a large wheat surplus. The outlook then is for this country to become of increasing importance in the wheat commerce of the world.

**The Wheat Region of British India.** — *Location and Extent.* — British India extends from 8° to 37° north latitude. Its northern extreme thus lies farther south than does the greater part of the United States. Its area is approximately one half as great and its population is about three times as large. The density of the population as well as its position is in marked contrast with that of Asiatic Russia.

Wheat is grown to some extent in nearly all parts of India, but the great wheat district is in the north, especially in the northwest provinces. The wheat area of India is approximately one ninth of that of the entire world.

The Punjab district, in northwest India, because of the development of irrigation systems has come to be of great importance as a wheat producer. The methods of irrigation here vary from those where wells and storage tanks are used to highly developed river and canal systems. Because of

the smooth land and the low river banks in the Punjab district, the system where canals from the river are used has developed rapidly.

*The Seasons.* — The Indian year has three seasons, — the hot, the rainy, and the cool. The hot season begins in March and lasts until July; the rainy season is from June to October, during the southwest monsoon; and the cool season covers the balance of the year. During the rainy season all of India except a strip along the east coast receives much rain. During a single season the variance in amount of rainfall for different parts of India is decidedly great. Likewise the amount in a single district varies greatly from year to year. This uncertainty has caused many crop failures and famines and has led to the use of the irrigation systems.

Two crops are grown each year, — the summer crop and the winter crop. The summer crop is sown in June or July and is harvested in October and November. This crop is usually maize, millet, rice, or other grain. Wheat, in northern India, is the so-called winter crop. It is sown at the close of the southwest monsoon, September or October, and is harvested from Feburary to April. During the growing period of the wheat the sky is clear and the weather cool and dry. Thus the wheat ripens before the advent of the hot season.

*The Soil of the Wheat Region.* — A great part of

the wheat-producing area of India is confined to the large alluvial plains found along the Indus river and its tributaries. Here, as elsewhere in India, the success of the crop is due to the fact that a highly fertile soil is found in a region where there is a favorable climate.

*The Culture Methods.* — The varieties of wheat grown here are only those which make good white flour. The reason for this becomes evident when we realize that nearly all the wheat is sent to England and is there used in bread making. Thus wheat which gives dark or inferior flour does not find ready markets.

The soil is prepared toward the end of the monsoon period by the use of crude, wooden plows. Often several plowings are necessary. The wheat is generally sown by hand. In the south the harvest begins in February and advances northward with the season until in April northern India is reached. In many places reaping is still done with the sickle or scythe, and the threshing by treading the grain on an earthen floor and winnowing by hand.

Although the English have introduced modern machinery to some extent, progress is slow. This is because of the small landholdings and the poverty of the people. Few farmers have the capital necessary to purchase modern implements and, even were they able to do so, the native

Hindus would have difficulty in learning to operate complicated machinery. Slow progress is at best all that can be expected.

**The Production of Wheat in this Region.** — The total production of wheat in 1913 was reported to be 358,314,000 bushels. This is about typical of normal conditions. The average yield varies from 12 to 15 bushels per acre, though of course much higher yields occur in many places. Because of the small capital invested and the cheapness of labor, the cost of production is very low. This cheapness of labor may be in part explained by the fact that standards of living are not nearly so high among Indian wheat raisers as among those of North America.

**The Marketing of the Wheat.** — Because of the hordes of moths and weevils which attack it during the hot season, wheat in India deteriorates rapidly. For this reason it must be marketed as soon as possible after it is threshed. In the rush following harvest, transportation facilities are severely taxed. There are no elevators to care for the grain; and railway service is inadequate. In some parts of the country the wheat is delivered to the railway towns by bullock wagons or by human carriers. In other cases where streams are available, it is delivered to river and canal ports by small boats. From these receiving stations it is then carried either by rail or by boat to the larger

export centers and is there loaded into the ocean-going vessels.

**The Exportation of Wheat.** — Since the people of India live largely on other grains, especially rice, millet, and corn, a large percentage of the wheat produced is exported. Much hand labor is employed in loading the vessels, for native workers are plentiful and wages are low. Indian wheat is dirty and badly graded, in marked contrast to the clean and well-graded wheat from Canada. The inferior market condition of the Indian product is due to the circumstances under which it is raised. Most of it is grown on small peasants' holdings, is threshed by flail or is trodden out by bullocks on a dirt floor, and is winnowed by the wind. This growing of small patches in many districts causes a mixing of the varieties, and the poor threshing leaves it badly mixed with chaff and dirt. For these reasons in English markets the Indian wheat brings a lower price than that from Canada.

Although India has several good harbors, because of insufficient protection they nearly all suffer from the winds and storms of the monsoon season. The most important export centers are Karachi, Bombay, Calcutta, and Madras. In spite of the fact that its harbor is never safe for large steamers during monsoon storms, Karachi is India's greatest wheat-exporting center.

The harbors of India are not equipped with

large elevators such as characterize the seaports of eastern United States. The ocean steamers must lie at anchor some distance out in the harbor. The sacked wheat is carried in small boats, called *lighters*, from the shore to the freight steamers, and is there reloaded for its long journey. This is quite different from the methods employed in American seaports. There the harbors are sufficiently deep for the great steamers to lie alongside the elevators and to be loaded by letting the grain slide through chutes into the hold of the vessel.

**The Export Routes.** — England furnishes the principal market. Exports from India are sent *via* the Suez Canal and the Mediterranean Sea to the English seaports, Southampton, London, and Liverpool. Freight steamers usually make this trip in from thirty to forty days.

The surplus wheat of India is exchanged for the manufactured goods of Great Britain. India thus serves as a market for the manufactures produced by English labor, and she is also an important contributor to England's food supply. India, Canada, and Australia are the great wheat-producing colonies of Great Britain.

### Questions and Exercises

1. Of what importance is Asia in the early history of wheat?

2. Why are so few Asiatic countries important contributors of commercial wheat?

3. How does Siberia compare in size with the United States? What part of Siberia is now important in wheat production?

4. What characterizes the cultural methods of wheat production in Siberia? Why are American manufacturers interested in developing better methods there?

5. Account for the primitive methods of cultivation and harvest still in vogue in Turkestan.

6. Explain how Asiatic Russia is situated with reference to natural transportation facilities. What steps have been taken by the Russian government to remedy this condition?

7. How will improved transportation facilities affect the development of the wheat industry?

8. What countries serve as the markets for the wheat exported from Asiatic Russia? Trace the trade routes.

9. Where are the most important wheat districts of India?

10. What relation does the climate of India bear to its wheat production?

11. Why is modern machinery not used generally in India?

12. What conditions render early marketing of wheat imperative in India? Of what importance is climate in this respect?

13. Explain why India, in spite of very dense population, is an important wheat-exporting country.

14. To what country is the greater part of the Indian export wheat sent? by what routes?

15. Compare the market condition of wheat from India with that from Canada. Account for the difference.

# CHAPTER XVII

## *WHEAT IN EUROPE*

EVERY country in Europe produces wheat. Even on the plateaus and mountain regions of Montenegro, of Switzerland, of northern Spain, and of Portugal, it is an important food supply. In some of these places, however, where soil and climate are unfavorable to the common wheats, the small primitive type, Einkorn, is the only kind that is grown. Commercially wheat is of great importance only in the following countries: Russia, Austria-Hungary, the Balkan States, Italy, Spain, France, Germany, and the United Kingdom. These countries are representative of all parts of Europe.

**The Wheat Region of Russia.** — *Climate and Soil.* — Practically all of European Russia south of latitude 58°–60°, as far as temperature is concerned, permits wheat production. The actual wheat region, however, begins several degrees farther south. The rainfall varies from less than 10 inches per year in the southeastern part to about 24 inches in the region near the Baltic Sea. The greater part of the rainfall occurs during the growing season.

FIG. 121. — Map of Europe.

The soil generally is fertile, that of the Black Earth district being particularly so. Since the Steppe region of the southeast is salty in many places, and has a deficient rainfall, it is not fitted for wheat production.

*Culture Methods.* — The methods of production vary from the most primitive to the most advanced.

FIG. 122. — A wheat harvest in Russia.

Among the poorer classes of farmers, the small landowners or tenants, the common plow is considered a luxury. With them, hand labor is involved in every process, whether it be turning the ground by wooden plows, harvesting the grain by sickle or cradle, or threshing by flail. The private holders of large estates and the larger farmers employ methods which are similar to those

used in the United States. This class of producers operate gang plows, press drills, and modern binders and threshers. In fact during recent years southwestern Russia has been a good market region for American-made machinery, particularly for binders.

*Kinds of Wheat.* — Conditions are favorable for winter wheat and it is grown extensively in both Poland (western Russia) and in the vicinity of the Black Sea. In Poland snows protect the wheat from being winterkilled, and in the Black Sea region the temperatures in winter are moderate, and wheat is able to live through the season.

Generally, however, spring wheat is the more important and is approximately four fifths of Russia's total production. This is because of the fact that during much of the time of the low temperatures which occur in winter over a great deal of the region, the ground is not protected by a snow cover. These conditions are naturally unfavorable for winter varieties.

Russian wheats are of good milling qualities and are much in demand in European markets for flour purposes.

*The Extent of Wheat Production in This Region.* — Because of the crude farming methods and the lack of intensive agriculture, the yield is very moderate. During the years 1908 to 1912 the average yield reported varied from 9 to 11 bushels

per acre. Nevertheless on account of the large acreage the total production is high. In 1912 it amounted to about 624,000,000 bushels. Among the countries of the world Russia ranks second only to the United States. With the opening of wheat territory which now lies unused and the introduction of modern farming methods, Russia is in position to make a strong bid for the first place in wheat production.

*The Marketing of Wheat in This Region.* — Although many elevators have been built during recent years to facilitate the handling of grain, the greater part of the wheat is still marketed in sacks. Canals and railways furnish fairly good market facilities. Nearly one half of the freight tonnage carried by the railroads consists of wheat or wheat products, and even then over 20 per cent of the grain is carried on waterways. This emphasizes the fact that wheat is Russia's greatest commercial asset.

In exports Russia takes high rank. In 1911 more than 150,000,000 bushels of wheat were sent to other countries. This is nearly twice as much as was exported by the United States in the same year. The yield varies so much with different years that comparisons are difficult, but Russia is always one of the world's greatest exporters. The chief export centers are Riga and Odessa. The latter is now said to be the greatest wheat-

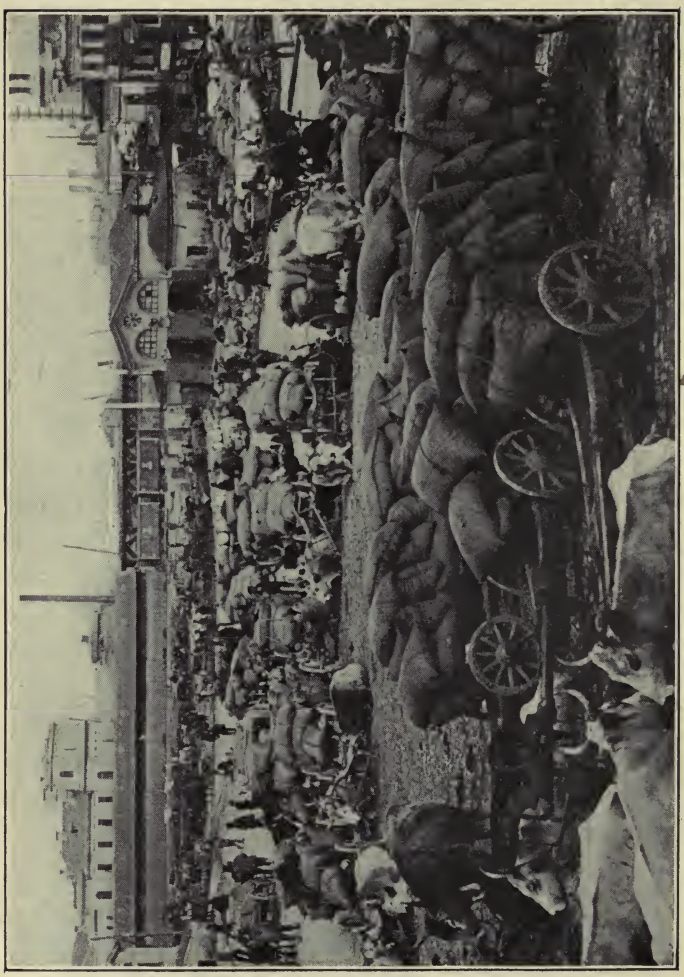

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FIG. 123. — Wheat ready for shipping, Odessa, Russia.

exporting city in the world. Markets are found in Italy and the countries of western Europe. Wheat is sent by rail to Germany and by way of the Mediterranean to Italy, France, and Spain.

Russia has thus become one of the chief factors in the production of the world's bread supply; and the crop in that country, because of its great export relations, is important in determining the price of wheat in every market of the world.

**The Wheat Region of Austria-Hungary.** — *Position, Climate, and Soil.* — The greater part of Austria-Hungary lies between the 45th and 50th parallels. A narrow strip, however, extends southward along the Adriatic Sea to latitude 42° north.

Moderate temperatures prevail, though great differences exist because of the irregularity of the surface, which varies from low-lying plains to high mountains. In general the summers are hot and the winters rather severe. The rainfall ranges from 25 inches per year in the southeastern plains to over 100 inches annually in parts of the Alps.

The plains of Hungary constitute the most important wheat region. There the land is quite smooth and the soil well adapted to wheat.

*The Culture Methods.* — Both spring and winter wheats are grown, but the latter because of the influence of climate is by far the more important.

Intensive farming predominates. The rural population is dense and the fields are small.

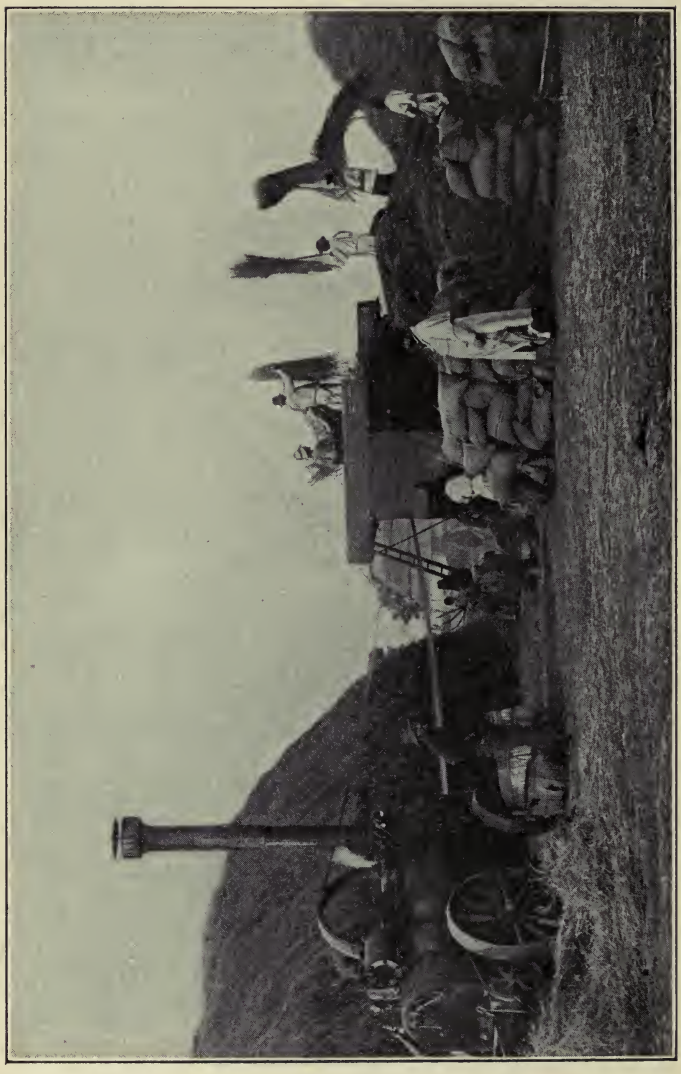

FIG. 124. — Threshing wheat in Hungary.

Most of the farms are less than 45 acres in extent. Since great advances have been made in providing machinery suitable for the small fields, hand labor is now much less important here than in former times. Small harvesters and threshers have quite generally replaced the cradle and the flail. In many cases several farmers unite in purchasing one machine. Exchange of machinery is also much practiced. By such methods the amount of capital invested is kept low and still labor-saving machinery is placed within reach of the mass of the people.

*The Production of Wheat in This Region.* — Although the total amount of wheat produced in Austria has increased over 75 per cent since 1880, the production is still not equal to the home demand. The total production in 1912 was 257,347,000 bushels and the yield per acre was 20.4 bushels. The yield in the wheat centers of Austria and Hungary is higher than the figure given, but the average is reduced by the unfavorably situated fields of hilly and mountainous sections.

The wheat is of exceptionally high milling quality. This is a result of the hot, dry ripening season. The harvests are almost free from rain so that the grain is seldom bleached or damaged by moisture. Flour is made throughout the country, and many small flouring mills are in operation. Budapest, however, is the great milling center of

the empire. The most up-to-date milling machinery is used there and flour of the highest quality is produced. Austrian flour is normally in great demand in English markets.

**The Balkan States Wheat Region.** — Although wheat is of local importance in all the countries of the Balkan Peninsula, Roumania, Bulgaria, and Serbia are the only ones which furnish much wheat for export. Greece, Montenegro, and Albania not only do not produce enough for home consumption, but must even import in order to meet their needs.

*The Roumanian Field.* — Roumania, although called a Balkan state, is really a continuation of the Russian plain. It not only includes part of the valley of the Danube river, but also the greater part of its extensive delta region. The wide central plain, a continuation of the Black Earth region of Russia, has a warm, rich soil and is well adapted to wheat growing. The country is, however, one of extremes of climate. It has very hot summers, with temperatures frequently rising above 100°, long autumns and very cold winters. Winter temperatures often drop to 20° below zero. The spring season is very short. Although the annual rainfall is 20 inches, much of it comes in the winter as heavy snowfall. The latter part of the summer is very dry.

Hard wheats are raised. Winter varieties,

among which is the well-known Turkey Red, are most profitable. Occasionally there will be an open winter and because of the lack of snow cover the wheat will winterkill. In this event spring wheats are sown as early as the season permits.

Here the plow is a peculiar machine. Two wheels are in front and the wooden plow proper behind. The peasant yokes up his two or three pairs of oxen with the old fashioned clumsy wooden yoke and proceeds to the field. His boy acts as the driver and he is left free to guide the plow. The sowing is done by hand.

June is the harvest month. In harvesting the men and women wield the simplest kind of reaping hook or scythe and the children, following, gather the wheat stalks and spread them on the field to dry. When dry, the wheat is taken to the stack or barn and the poor people who wish to do so may come and pick up the stray stalks that are left in the field. These people are known as gleaners.

The wheat, with the heads all pointing in one direction, is spread out about an inch thick on the floor and is threshed with the flail. The grain so spread is called haulm. On the larger farms the threshing is done by having a loaded cart pulled over the haulm as it lies on the floor. Few steam engines are in use, although they are beginning to be introduced in some places.

Roumania produces between 75,000,000 and

100,000,000 bushels of wheat every year. Since she sends out nearly three fourths of the wheat she produces, her exports are important. In 1911 they were nearly as large as those of Australia. Because of its macaroni qualities, much of the wheat is sold in Italy. The data given illustrate the importance of this small Balkan country in producing the world's bread supply.

*The Bulgarian Wheat Fields.* — Bulgaria lies in about the same latitude as New York. Its wheat-producing area covers about 4300 square miles and the northern part of the country produces the greater part of the crop. This area consists chiefly of the plains which lie between the Balkan Mountains and the Danube River. The climate is similar to that of Roumania, except for a somewhat heavier rainfall, which comes largely during the spring and winter months.

The cultural methods, though still crude in many places, are rapidly becoming modernized. The average size of fields is about eighteen acres. When the country was under the direct control of Turkey, the people were kept ignorant and superstitious, and, consequently, they would not use machinery. Since the country has become independent of Turkey, the native rulers have worked hard to introduce modern methods in farming operations.

Winter wheats are the principal varieties and

the harvest season comes in the latter part of June and early July.

The total production is nearly 50,000,000 bushels annually, of which about one-third is exported. Much of this wheat is shipped by way of the Black Sea and the Bosphorus to Greece and Italy. Some of it goes to the countries of western Europe.

*The Serbian Wheat Fields.* — The climate of Serbia favors wheat. The winters are moderate, the spring season is moist and cool, and the summer is quite warm and dry. Only about one third of the country, however, has land suitable for farming.

Almost every peasant cultivates his own field, which consists usually of from 10 to 30 acres. Because of the primitive methods of farming, modern machinery is seldom used. Women are taught that tilling the soil is as truly their work as is housekeeping. The poorer kinds of wheat, especially spelt and emmer, are the types grown. Russian wheats, which are so well adapted to Serbian conditions, have been slow to find favor.

In spite of their crude methods the Serbians usually export from three to four million bushels every year. Since the events of the Balkan War demonstrated to all these countries the advantage of improved methods, not only in war but in industry, it is probable that development will be more rapid. Lack of transportation facilities is

here a handicap to export trade. Serbia is without navigable streams to the coast and her railways are not well developed. The Mediterranean countries are her chief markets.

**The Wheat Region of Italy.** — "Sunny Italy" is a phrase with which we are all familiar. This term is applied because the country as a whole has a very large percentage of days of sunshine. The lack of cloudiness is illustrated by the fact that Italy averages three hours more of sunshine every day during the growing season than does eastern England. The rainfall, which varies from 20 to 40 inches per year, comes chiefly in the winter and spring seasons. In fact rain is so closely associated in Italy with the chilly and sunless season that the average Italian is inclined to shudder at the mere mention of the word. The summers are warm and dry. Because of the lack of summer rains, irrigation is extensively developed in agricultural lands. This is particularly true along the coast and in the Po valley.

*The Methods of Cultivation.* — Wheat, which occupies about 18 per cent of the cultivated land, is the most important cereal crop. Fields are small, varying in size from two or three, to thirty acres. The latter is considered a large field. Although the modern plow, harrow, and seeder are used in some places, methods of tillage generally are crude. The sowing is for the most part done by hand.

Spring wheats, macaroni, and spelts, are extensively grown, and the harvest season comes in May and early June. The grain is cut by sickle or cradle, and bound by hand. The flail is in general use for threshing. Harvesting and threshing machinery are of late coming to be used more generally,

FIG. 125. — Wheat harvest in Italy.

but because of the small fields and the lack of capital among the peasants, the introduction is slow. Nearly every farmer raises wheat for his own use, and has some to sell to the city trade. Since not enough wheat is grown to supply the home demand, Italy imports each year from thirty to forty million bushels.

The average yield of wheat is from 12 to 16

bushels. The total crop in 1913 was 214,405,000 bushels. This was an unusually large crop although production frequently reaches about 190,000,000 bushels.

*The Wheat Products and Their Uses.* — The province of Tuscany as well as the vicinity of Milan have become noted as straw-producing centers. Here wheat is grown for the straw which is used in the plaited straw industry, now very important in Milan, Pisa, and Leghorn. The straw-plaiting is a domestic and rural industry. The girls, over 20,000 of them, who plait the straw also tend the crop during its planting and growing season. The making of hats is a factory industry which centers in the cities. Italian straw has a market the world over for its use as a hat material.

Italy is the native land of the macaroni wheat, so called because of the product which is made from it. The processes of manufacture of macaroni differ somewhat from those of ordinary milling. The wheat is washed, soaked, and then made into a flour called semolina. Semolina, which is much coarser than common wheat flour, is made into a dough, rolled, cut into strips, and then dried. These dried strips, macaroni, make a very nutritious food which, because of its cheapness as well as its nutritious value, has served to displace meat dishes to a large extent. Not only

are the Italians particularly fond of macaroni, but many other countries also use it extensively. This widespread use has developed almost entirely within the last quarter century, for the macaroni industry began on a commercial basis in Naples only about 1875. Macaroni now is about the

FIG. 126. — An Italian bread baking oven. Note the two long loaves in the foreground ready to be placed in the oven.

only wheat product which serves as an article of export.

An interesting thing in connection with wheat products here is an Italian method of bread making. It is of interest chiefly because of the large loaves. The oven is often a little stone building which is used only for baking purposes. A fire is kept going in this oven until the stone

walls and floor are thoroughly heated. The coals and ashes are then removed and the floor is carefully wiped. This done, the loaves are placed inside and the openings are sealed. The bread is thus baked by the heat stored in the walls and floor of the oven. The loaves are large, sometimes six feet long, eighteen inches wide, and twelve inches high.

The ovens and loaves just described are common, although the smaller, more familiar, sizes are also found.

The transportation facilities are good. Development, however, of roads, canals, and railroads has been along lines of getting wheat to the people; that is, for import rather than for export purposes. The great import centers are Genoa, Rome, Naples, and Venice. As has been previously stated, Italy imports considerable quantities of wheat which serves as the raw material for the manufacture of macaroni. This is then exported as a finished article of commerce.

**The Wheat Region of Spain.** — The Iberian peninsula has a climate of extremes. The fringe of mountains around the coast condenses the moisture borne by the winds from the sea and gives the coastal provinces, especially in the north and west, an abundant rainfall, often more than 60 inches per year. The interior on the contrary is quite dry. The average annual rainfall of the

interior plateau of Spain is only 12 to 20 inches, with the greater part of this coming in the winter.

Wheat is grown in all parts of Spain. The region of greatest production, however, lies north of Madrid. In the drier parts of interior Spain, the small spelt is grown because it can be produced on poor soils and is more drought-resistant than other wheats. It grows only to a height of from 18 to 24 inches, has but one seed in a spikelet, and gives a small yield. In the more important wheat sections, Polish wheat or flint wheat is raised. This develops a larger plant but is likewise not a heavy yielder.

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FIG. 127. — Harvesting wheat in Northern Spain.

*The Culture Methods.* — Hand methods of tillage are used in most parts of the country. Wooden plows drawn by oxen are used to turn the soil;

sickle and scythe are the harvesting machines; and horses and goats are used to tramp the wheat kernel from the straw. The wagons are fitted with clumsy wooden wheels, and the roads are poor. June is the month of harvest.

*Copyright by Underwood and Underwood.*

FIG. 128. — A clumsy cart used for hauling grain in Spain.

On the plateau much land lies unused. The inhabitants lack enterprise both in tillage methods and in bringing available land under cultivation. Agricultural resources are neglected by the Spaniards because of want of capital, difficulty of

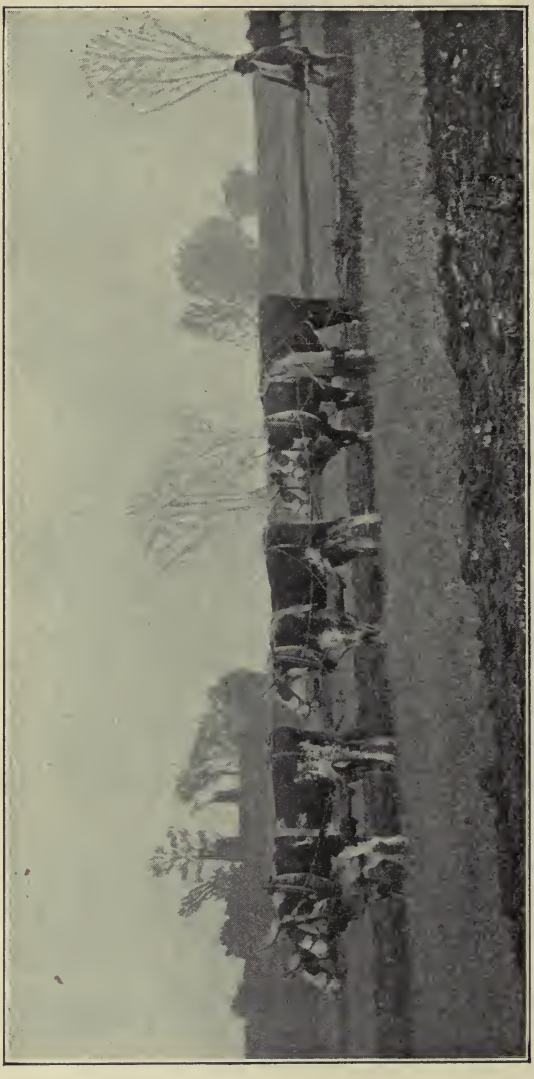
communication, and heavy taxation. The last has fallen with such great weight on the farmers that the actual tillers of the soil live in poverty.

The annual production is about one seventh of that of the United States. The average yield per acre is from 10 to 14 bushels. Except in unusually good years, wheat must be imported to meet the home demands.

*Marketing the Crop.* — The methods of marketing are poor. Farmers raise just enough for the community and this is then ground at the town mill. Wheat here is all handled in bags. Pack mules and ox carts are still common and means of communication are generally primitive. Although railway development has proceeded with some rapidity during recent years many sections are still very poorly served.

**The Wheat Region of France.** — *Position and Climate.* — France, whose area is about four fifths that of Texas, lies in the same latitude as northern United States and southern Canada. Since it is so situated that the Atlantic winds have free access almost everywhere, the country has an equable climate. Winters are moderately cold, and summers are mild. The rainfall averages about 30 inches per year.

*Culture Methods.* — Among European countries, France is second only to Russia in total production. Although only one eighth of its area is



*Courtesy Physiography Laboratory, Cornell University.*

FIG. 129. — Plowing with oxen, France.

planted to wheat she produces nearly enough for her own use, importing ordinarily only from 2 to 10 per cent of her needs. The soil is generally fertile. Where it is poor it is brought up to good producing capacity by the use of fertilizers and

FIG. 130. — Threshing wheat in Brittany, France.

advanced methods of farming. Small fields and careful tillage is the rule. Women do much of the work in the fields of France.

Walking plows pulled by one or two horses or a yoke of oxen is the usual means of plowing, and

FIG. 131. — Havre, France.

hand sowing is customary. The harvest, which is now largely accomplished by machinery, occurs in July. Only where fields are very small or hilly is the sickle or scythe used. Most of the wheat is cut with small binders which are similar to the larger ones used in the United States. The threshing is done with small machines operated by horse power. The threshers are fed by hand and the straw is removed by the same means. These machines, however, do good work and are efficient for small farms.

*Production and Uses.* — The yield is high, averaging for the whole country from 18 to 20 bushels per acre. The French Government takes an active part in encouraging all forms of agriculture and gives much attention to the solution of wheat problems.

Both spring and winter varieties are raised. Because of its high yields Durum wheat is becoming more and more popular. The macaroni industry has here also grown by leaps and bounds in the past few years. It seems as though the French are likely to become worthy rivals of the Italians as macaroni eaters.

*Marketing the Crop.* — France is noted for her splendid public roads, the "routes nationales," which are built and maintained by the state. The river and canal routes likewise permeate the entire country, and France has a highly developed

system of railways. The efficient means of transportation together with the many large cities give all the agricultural sections easy access to good markets. The wheat is generally sold to local elevators and mills. There it is prepared into flour and other food products for home consumption. Although wheat importation is necessary to meet the demands for flour, imports of wheat are ordinarily kept down by a fairly heavy duty. This is for the purpose of encouraging as large home production as possible.

*Wheat Imports.* — Russia, Argentina, and the United States furnish most of the imports, though some come from the Balkan States, India, and Canada. Marseilles, Bordeaux, and Havre are the greatest import centers. Very little wheat flour is imported. This arises from the fact that home milling is strongly favored.

**The Wheat Region of Germany.** — Although in the northeastern part the winters are cold, the climate of Germany on the whole is mild. The rainfall ranges from 16 inches in the middle Rhine basin to more than 30 inches in the southern highlands and along the North Sea. The rain, though not limited to any season, comes for the most part during the summer.

*Culture Methods.* — The wheat acreage in Germany is only a little more than one fourth that of France. This is due to the fact that rye and

barley are used as the bread cereals much more extensively than is wheat. In fact the Germans are noted as "black bread" eaters, although in recent years wheat bread has been gaining in favor rapidly. The principal wheat regions are in the southern and western parts of the country.

German farms are small but every foot of ground is made to yield as much as possible. Intensive farming, rotation of crops, and the extensive use of fertilizers have built up the German farm to a high point of efficiency. They are now being referred to even in the United States as examples of what can be accomplished by modern agriculture.

Small machinery is used almost entirely. Measured by the standards of the machinery used on the large fields of the United States or Canada, one might be tempted to say that the Germans are not up-to-date. This assertion would not be true; for their machinery is well adapted to the sizes of their fields. In acreage the farms range from two to thirty acres, the latter representing a large field. As in France, the work is generally done with small plows, harvesters, and threshers. In some places, though, the cradle and flail are still in use.

The total production in 1913 was 171,075,000 bushels, representing an average yield of more than 35 bushels per acre. Although German wheat is softer than most of the American wheat,

it is of good milling quality. Much spelt and emmer are grown.

*Marketing the Crop.* — Germany, like France, has highly developed transportation facilities in its excellent wagon roads, canals, and railways. The numerous large cities demand more wheat than the country produces, so prices are good and markets easily accessible. Most of the wheat is handled in sacks and sold to local mills.

*Wheat Imports.* — As a world's wheat market, Germany is especially important since, with the exception of Great Britain, she imports more than any other country. Her imports equal 50 to 60 per cent of her own total production. Great quantities of wheat grown in the United States thus find markets in German cities. For this wheat Hamburg and Bremen are the greatest import centers. A great deal of wheat is also bought from Russia, much of which is shipped by rail. But a very small percentage of the wheat imported is in the form of flour. The Germans prefer to do their own milling.

**The Wheat Region of the United Kingdom of Great Britain and Ireland.** — The United Kingdom lies in about the same latitude as Manitoba, Canada. Because of its insular location in the belt of prevailing westerly winds, the climate is mild and equable. The winters are rainy and chilly, and the summers warm but not hot.

Although small quantities of wheat are raised in Scotland, Wales, and Ireland, the eastern part of England is the chief producing section. The annual rainfall in the principal wheat section is about 30 inches, and it is fairly well distributed through the year. It is lowest in the summer months.

*Photo by H. J. Young.*

FIG. 132. — Wheat plots at Rothamsted Experiment Station, Harpenden, England. Both plots have been continously cropped with wheat for seventy-one years. The plot at the right has received no fertilizer and gives now a yield of about thirteen bushels per acre. The left plot has had annual applications of fertilizer and now yields about forty-one bushels per acre.

*Culture Methods.* — Both spring and winter wheats are grown, of which the soft white varieties are the most common. The English wheats because of the warm, moist climate are on the whole more starchy than those of the United States. Wheat may be sown in any of nine months of the year. The best results are obtained when the

land has been summer fallowed the season before planting. The land is plowed in August, allowed to stand about two weeks in order that the herbage may die, and is then cross plowed. Later it is harrowed, packed, and thus made ready for seeding.

Winter wheats are sown in early autumn,

*Photo by H. J. Young.*

FIG. 133. — A small wheat field at the Harper Adams Agricultural School, England. Large yields reward careful and intelligent methods of production.

usually in September, although sometimes as late as December. Spring wheats are sown from January to March. The press drill is the common means of seeding, although broadcast sowing is still practiced in some districts. From one and one half to three bushels of seed are sown per acre.

*Harvesting the Crop.* — August is the general harvest month. The methods of harvesting vary

from cradle to binder. Up-to-date machinery is, however, the rule. Most of the wheat is stacked, sometimes in barns, often out of doors on raised stack stools which prevent the stack bottoms from molding. Except in isolated regions where the flail is still employed, the modern thresher is used.

The total annual production is about 60,000,000 bushels with an average yield of a little more than 30 bushels per acre. On the well cared for fields of eastern England, yields of 60 bushels per acre are by no means uncommon.

Transportation facilities are excellent. The country roads are as well kept as are many of the boulevards which lead to American cities. Railways ramify every part of the region and thus place the producer within easy access of the greatest wheat markets of the world.

**The Wheat Markets of Great Britain.** — Since Great Britain consumes much more wheat than she raises, the markets are largely local. There is no need of such an extensive system of marketing as is in operation in the United States.

In spite of a comparatively large production, Great Britain imports about 180,000,000 bushels of wheat annually. For import purposes her location is splendid, for she is within easy reach of the great wheat fields of the world. She strives to obtain her necessary imports as largely as possible

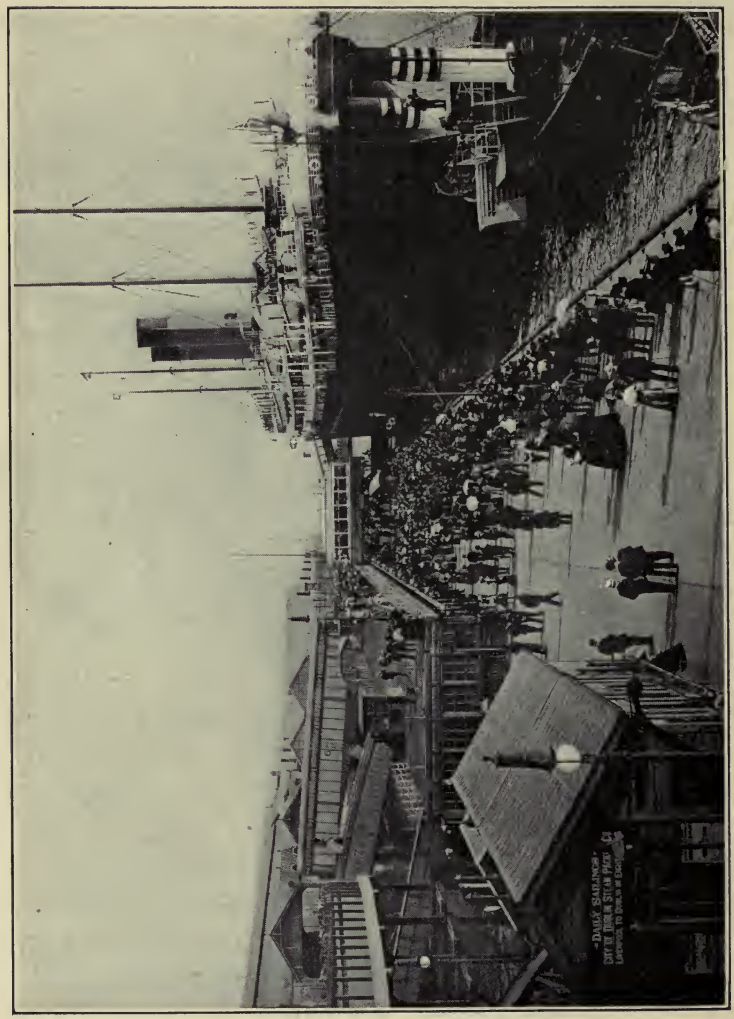



FIG. 134. — Liverpool.

from her own colonies, India, Australia, and Canada, but she also buys large quantities of wheat every year from Argentina, Russia, and the United States.

Great Britain is dependent upon other countries not only for much of her food supply, but also for her raw materials for manufacture. Her industries consist chiefly of converting raw materials into finished articles of commerce. In order to insure a supply of the necessary materials and foodstuffs, she has developed shipping interests that outrank those of any other nation. English ships are found on every sea. Her merchant vessels serve to bring her foods and raw materials and to carry her manufactured goods to foreign markets. To protect her commercial interests as well as her colonies she has built and now maintains the world's greatest navy.

Because of the large imports of wheat needed by Great Britain, she plays a very important part in the world's market. Her greatest import center is Liverpool, which has developed into the first wheat market of the world. The crop reports of every wheat country of any importance are wired daily to this city. These reports affect the Liverpool market, and that in turn controls the price of wheat the world over.

In conclusion, we need only to be reminded that we began our study of the world's wheat crop

where acres are many and people few; we close it with the country where acres are few and people many. Production and markets are both necessary and the interplaying movements between these factors are well illustrated with wheat, the greatest bread cereal.

### Questions and Exercises

1. In what European countries is wheat of great commercial importance? Why are not all countries named?
2. What part of European Russia is important in wheat production?
3. Why is spring wheat of greater importance in Russia than is winter wheat?
4. Of what importance is the wheat crop of Russia in affecting the world market? Why?
5. Suggest reasons why the average yield per acre of wheat is higher in Austria-Hungary than in Russia.
6. What conditions have led to the development of Austria-Hungary as a great milling country?
7. What Balkan countries are important producers of wheat for export?
8. What causes favor the production of macaroni wheat in the Balkan States? Consider both climate and market conditions.
9. Why do small fields in a country tend to retard the introduction of modern machinery?
10. Are the so-called crude methods of tillage and harvesting necessarily uneconomical? Do they necessarily indicate lack of intelligence among the people using such methods?
11. Suggest reasons for the development of the macaroni industry in Italy.

12. Why does not Spain take high rank as a wheat producing country?

13. Compare the latitude position of France with that of the United States.

14. Discuss the adaptation of methods of production to natural agricultural conditions in France.

15. What is the attitude of the French government toward agriculture? Why such interest?

16. How do the French encourage home milling of wheat? Why?

17. What are the chief wheat import centers of France? What countries furnish the greater part of the wheat imported?

18. Briefly discuss the methods of wheat production in Germany.

19. What is true of the average yield per acre in Germany? How has this result been accomplished?

20. Of what importance is Germany as a market for American wheat? What are its chief import cities?

21. Why do the Germans prefer to import wheat rather than flour?

22. What is meant by the *insular* position of Great Britain?

23. What is the greatest wheat importing country in the world?

24. What countries furnish the greater part of English wheat imports?

25. From the standpoint of wheat alone what reasons can you suggest why England finds it necessary to maintain commercial supremacy on the sea?

26. In a brief statement explain how the international trade in wheat is of advantage to both importing and exporting countries.

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